

Mineral of the Month Club April 2017

QUARTZ, subvariety FLINT

This month's featured mineral is the flint subvariety of chalcedony, or microcrystalline quartz. Our specimens are from the prehistoric flint-mining locality at Flint Ridge, Ohio; our write-up details the properties of flint and explains its importance throughout history.

OVERVIEW

PHYSICAL PROPERTIES

Chemistry: SiO₂ Silicon Dioxide. The flint subvariety of quartz contains varying amounts of iron, water, and other impurities.

Class: Silicates

Subclass: Tectosilicates (Framework Silicates)

Group: Quartz

Subgroup: Chalcedony (Microcrystalline Quartz)

Crystal System: Hexagonal

Crystal Habits: Microcrystalline, occurs in massive form as veins, layers, and nodules.

Color: Flint is usually white, black, gray, or brown, but can also be red, yellow, green, or blue; multicoloration is common.

Luster: Waxy to dull

Transparency: Semitranslucent to opaque

Streak: White

Refractive Index: 1.530-1.539

Cleavage: None

Fracture and Tenacity: Conchoidal; tough.

Hardness: Macrocrystalline Quartz, Mohs 7.0; Chalcedony, 6.5-7.0.

Specific Gravity: Macrocrystalline Quartz, 2.65; Chalcedony, 2.58-2.64.

Luminescence: None

Distinctive Features and Tests: Best field marks are semitranslucency or opacity, hardness, conchoidal fracture, occurrence as nodules and veins in formations of limestone and chalk, and microcrystalline structure. Flint can be confused with jasper, chert, and other forms of chalcedony.

Dana Classification Number: 75.1.3.1

NAME: The name "quartz," pronounced KWORTZ, stems from the German *Quarz*, which in turn is derived from the Slavic word *kwardy*, meaning "hard." The word "chalcedony," pronounced "cal-SEH-duh-nie," stems from Chalkēdōn, an ancient Greek city in Asia Minor. The word "flint" is rooted in the Old High German *flins*, meaning pebble or hard stone. Flint has also been known as "fire stone," "thunder stone," "nightmare stone," and "spark stone." In

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European mineralogical literature, flint appears as *pedernal*, *pietra focaia*, *Feuerstein*, and *vuursteen*.

COMPOSITION: Flint is an impure, semitranslucent-to-opaque form of chalcedony, the microcrystalline variety of quartz. The chemical formula of quartz, SiO_2 , shows that chalcedony contains two elements, the semimetal silicon (Si) and oxygen (O). Quartz's molecular weight is made up of 53.26 percent oxygen and 46.74 percent silicon. The fundamental building block of all silicates is the silica tetrahedron (SiO_4)⁴⁻, which consists of a silicon ion surrounded by four equally spaced oxygen ions positioned at the four corners of a tetrahedron (a four-faced polyhedron). As an allochromatic (other-colored) mineral, the colors of macrocrystalline quartz are caused by traces of nonessential, color-producing elements called chromophores that alter the light-reflectance properties of the crystal lattice. However, the colors of flint, which is microcrystalline, are due mainly to impurities. Black flint contains elemental carbon from organic sources or finely divided metal sulfides such as pyrite [iron disulfide, FeS_2]. Metal oxides and hydroxides, mainly hematite [iron oxide, Fe_2O_3] and goethite [basic iron oxide, $\text{FeO}(\text{OH})$], impart red, yellow, and brown colors. Because of its variable composition, flint is classified as a chemical-sedimentary rock, which is defined as a sedimentary rock composed mostly of material formed directly by precipitation from solution or colloidal suspension. Flint forms when silica solutions circulate through limestone or chalk formations to displace calcium carbonate and replace it with precipitated, impure chalcedony as nodules or veins of varying sizes.

COLLECTING LOCALITIES: In the United States, notable flint deposits are located in Ohio, Texas, Kansas, Oklahoma, Kentucky, Indiana, Georgia, South Carolina, New York, Wyoming, Iowa, Utah, Missouri, Connecticut, and Arkansas. Other sources are located in England, Portugal, France, Germany, Italy, Denmark, Spain, Belgium, Poland, Switzerland, the Netherlands, and Israel.

HISTORY, LORE & GEMSTONE/TECHNOLOGICAL USES: Flint was among the first mineral materials to be collected and utilized in Paleolithic times. Because of its conchoidal fracture, flint was easily worked and flaked into edged and pointed tools, or points for arrows and spears. Archaeologists have recovered flaked flint artifacts with 2.1-million-year-old human remains. Flint was also one of the first important trading commodities. By 5000 B.C., flint was being systematically mined in many areas of Western Europe, Africa, and North America. Because iron produces sparks when struck against flint, flint has served as a "fire-starter" since around 600 B.C. in all cultures that had access to iron. Because of its sparking ability, flint was associated with thunder and lightning and was used as a talisman to protect against such phenomena. In ancient Rome, flint "cobbles" were a durable building material. Iron-flint sparking mechanisms assumed great importance after 1570, when the flintlock rifle was introduced in Germany. Flintlock rifles employed pieces of shaped flint attached to spring-loaded metal arms. When the trigger was depressed, the arm moved forward, causing the flint to strike an iron plate and produce sparks that ignited a gunpowder charge. Today, multicolored

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flint is a gemstone that is fashioned into cabochons and beads for use in jewelry. Flint with attractive, multicolored patterns is also flaked into arrowheads and spear points for display purposes. Modern metaphysical practitioners believe that flint is a stone of power and intensity that connects the spiritual and physical realms, helps to ground flighty perceptions in reality, and enhances self-discipline, analytical abilities, emotional stability, and physical and intellectual strength. Flint has no modern technological uses.

ABOUT OUR SPECIMENS: Our flint specimens are from Flint Ridge, a low escarpment in Hopewell and Franklin townships in Muskingum and Licking counties, Ohio. This region is about 40 miles east of Columbus, the state capital, and just north of Interstate 70 in gently rolling farm country. The largest and best-known of Ohio's many flint sources, Flint Ridge is part of the Vanport Limestone formation which was deposited by shallow seas some 320 million years ago. Flint Ridge is an eight-mile-long, intermittent vein of high-quality flint with hundreds of ancient quarry pits and "workshop" sites. Ohio's native cultures, most notably the Hopewell Culture which thrived from 100 B.C. to 500 A.D., utilized Flint Ridge flint extensively to fashion spear points, arrowheads, scrapers, awls, and knives. In 1933, the Ohio Historical Society established the Flint Ridge State Memorial. In 1965, the Ohio General Assembly adopted Flint Ridge flint as Ohio's official state gemstone. The state later built a museum at the Flint Ridge State Memorial, which now includes a restored, prehistoric quarry, along with exhibits on flint uses and local geology. Today, Flint Ridge flint is shaped and polished into pendants and beads for use in jewelry and sold under such names as "Ohio Flint," "Vanport flint," "Hopewell flint," and "Flint Ridge flint." Professional flint-knappers also flake Flint Ridge flint into arrowhead, spear-point, and other forms for display purposes.

COMPREHENSIVE WRITE-UP

COMPOSITION & STRUCTURE

Flint is a rock that consists largely of chalcedony, the microcrystalline variety of quartz. Quartz [silicon dioxide, SiO_2] contains two elements, the semimetal silicon (Si) and oxygen (O). Quartz's molecular weight is made up of 53.26 percent oxygen and 46.74 percent silicon. The cation (positively charged ion) in the quartz molecule is the silicon ion Si^{4+} with its +4 charge. The anion (negatively charged ion) consists of two oxygen ions 2O^{2-} with their collective -4 charge. The +4 cationic charge balances the -4 anionic charge to provide the quartz molecule with electrical stability.

Quartz is a member of the silicates, the largest and most abundant mineral class. The fundamental building block of the silicates is the silica tetrahedron $(\text{SiO}_4)^{4-}$, which consists of a silicon ion surrounded by four equally spaced oxygen ions positioned at the four corners of a tetrahedron (a four-faced polyhedron). In the quartz-crystal lattice, all four oxygen ions in each silica tetrahedron bond covalently to the silicon ions of adjacent tetrahedra, with four oxygen

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ions surrounding each silicon ion and two silicon ions surrounding each oxygen ion. This arrangement satisfies the -4 charge of each silica tetrahedra and creates the infinite, three-dimensional structure of quartz, in which balanced molecular units are represented by the formula SiO_2 . Silicon and oxygen, the most abundant elements in the Earth's crust, comprise three-quarters of the total crustal weight. Quartz is a component of most igneous, metamorphic, and sedimentary rocks. In silicate minerals, silica anions bond with metallic or semimetallic cations to form repeating chains with seven distinct, structural configurations: independent tetrahedral silicates (nesosilicates); double tetrahedral silicates (sorosilicates); single- and double-chain silicates (inosilicates); ring silicates (cyclosilicates); sheet silicates (phyllosilicates); and framework silicates (tectosilicates). Quartz is a framework silicate or tectosilicate.

Because the covalent bonding within the quartz lattice exerts omnidirectional strength, quartz crystals have neither symmetry nor cleavage planes. This lack of cleavage together with the high bonding strength achieved through close atomic packing account for macrocrystalline quartz's substantial hardness of Mohs 7.0. Despite this close atomic packing, however, the light atomic weights of silicon (28.09) and oxygen (16.00) give macrocrystalline quartz a relatively low specific gravity of 2.65.

The Dana mineral classification number 75.1.3.1 first identifies quartz as a framework silicate or tectosilicate (75). The subclassification (1) defines it by its four-oxygen coordination, in which each silicon cation is bound to four oxygen anions in the $(\text{SiO}_4)^{4-}$ configuration. Quartz is then assigned to the quartz group (3) as the first (1) and only member.

Quartz occurs in two distinctly different forms: macrocrystalline and microcrystalline. Macrocrystalline quartz consists of crystals exceeding 50 microns (0.05 millimeters) in size and includes such familiar varieties as amethyst, rock crystal, and milky, smoky, and rose, which all occur as large, well-developed, individual, transparent-to-translucent crystals or groups of crystals. In microcrystalline quartz, or chalcedony, individual crystals are less than 50 microns (0.05 millimeters) in size. Chalcedony consists of interlocked, microscopic silica grains or fibrous silica crystals and includes such subvarieties as agate, jasper, chert, and flint.

Macrocrystalline quartz grows by adding silica on a molecule-by-molecule basis to form successive surface layers on crystal surfaces. Growth occurs at both high or low temperatures and pressures, and in environments where sufficient space permits orderly crystal development. Chalcedony, or microcrystalline quartz, on the other hand, forms from the solidification of colloidal silica suspensions in restricted space and in the low temperatures and low pressures of shallow environments. Chalcedony usually forms nodules or horizontal bodies or "lenses" in chemical-sedimentary rocks (rocks consisting mainly of materials formed by chemical precipitation) or occurs as fillings within amygdules of volcanic rocks. In either case, the chalcedonic-formation process begins with silica that has weathered free from silicate minerals and is carried in groundwater as colloidal suspensions or gels of microscopic particles. Over

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time, these gels lose most of their water to solidify into solid masses of chalcedony composed of interlocking, microscopic crystals.

Because of its microcrystalline nature, chalcedony lacks the structural homogeneity of macrocrystalline quartz. As a result, the hardness of chalcedony, Mohs 6.5 to 7.0, is somewhat less than that of macrocrystalline quartz (Mohs 7.0). Chalcedony is also a bit less dense than macrocrystalline quartz, which has a specific gravity of 2.65. The specific gravity of chalcedony, which contains up to four percent impurities, ranges from 2.58 to 2.64. With its homogenous crystal structure and higher purity, macrocrystalline quartz is transparent to translucent, while less-pure and less-homogenous chalcedony is semitranslucent to opaque. Macrocrystalline quartz has very low porosity, while chalcedony is quite porous. The structure of chalcedony varies from grain-shaped microcrystals (microgranular) to fibrous microcrystals (microfibrous), and is determined by the specific conditions of temperature, pressure, and chemistry that existed at the time it formed.

Macrocrystalline quartz and chalcedony are colored in different ways. Quartz is colored mainly by a primary process in which traces of nonessential, color-producing elements called chromophores alter the crystal lattice to impart various colors. Secondary coloration in quartz is usually limited to surface mineral staining. Primary coloration in chalcedony is rare and most colors are of secondary origin. When formed, chalcedony is usually gray or grayish-white, indicating minimal chromophoric content. But because chalcedony is quite porous, it is easily permeated by mineral-bearing groundwater solutions containing black particles of elemental carbon or the chromophoric ions of such elements as iron, manganese, and nickel. These groundwater solutions deposit minerals in the interstitial spaces between chalcedony's microcrystals to create a wide range of colors and color patterns. Shallow deposits of chalcedony are usually exposed to circulating, mineral-rich groundwater that imparts the secondary coloration that is typical of flint. Black flint contains particles of elemental carbon from organic sources or finely divided metal sulfides such as pyrite [iron disulfide, FeS_2]. Metal oxides and hydroxides, mainly hematite [iron oxide, Fe_2O_3] and goethite [basic iron oxide, $\text{FeO}(\text{OH})$] impart red, yellow, and brown colors. Changes in the chemistry of these groundwater solutions during the formation of chalcedony often result in multicoloration.

Flint is classified as a chemical-sedimentary rock, which consists primarily of material that has precipitated directly from solution or solidified from colloidal suspension. Flint forms when silica solutions or colloidal suspensions circulate through bodies of limestone or chalk, displacing calcite [calcium carbonate, CaCO_3] and replacing it with precipitated, impure chalcedony, usually in the form of nodules and layers of varying sizes. This process is called sedimentary diagenesis, which is a change in sedimentary rocks that occurs after lithification and at temperatures and pressures that are less than those required for metamorphism. Large quantities of flint weather free from original host formations; due to its hardness and durability, flint can survive alluvial transport over long distances and thus is often found in riverbed, plain,

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and valley sediments far from original, in situ sources. Flint is widely distributed and locally abundant.

COLLECTING LOCALITIES

Our flint specimens were collected at Flint Ridge in Hopewell and Franklin townships in Muskingum and Licking counties in southeastern Ohio. Large flint deposits are also found in Moore, Hutchinson, Carson, and Potter counties in the panhandle of Texas; Potter County is the site of Alibates Flint Quarries National Monument. Other Texas localities include the Seaquist Ranch at Grit in Mason County and various sites in Burnett, Williamson, and Blanco counties near Austin. The Flint Hills, which extend 150 miles north from Kay and Osage counties in Oklahoma into the Kansas counties of Cowley, Butler, Marion, Dickenson, Clay, and Riley, are another major source of flint. Flint deposits are also found in Carter County, Kentucky; Harrison County, Indiana; the Flint River gravels in Macon and Sumter counties, Georgia; the Savannah River gravels in Barnwell and Allendale counties, South Carolina; Greene and Oneida counties in New York; Goshen County, Wyoming; the Grant-Red Oak area in Montgomery County, Iowa; the Browns Hole area of San Juan County, Utah; Jasper and Newton counties in southwestern Missouri; Dyke Park, Stamford, Fairfield County, Connecticut; and the outer-rim region of the Ozark Mountains in northwestern Arkansas.

In Europe, flint is abundant in the massive limestone formations of southern England, Germany, Italy, Denmark, and parts of France, Spain, Portugal, Belgium, Poland, Switzerland, and the Netherlands. Important English flint localities include Grime's Grave at Lynford, Beeston Bump and the West Runton beaches near Norfolk, and Salisbury Plain near Dorset, all in South West England; and the Chalk Cliffs at Dover in East Anglia. In Portugal, flint is found near Campoldi and Sintra in Lisbon District; and at the Preguiça Quarry at Sobral de Adiça, Beja District. In France, flint occurs throughout the greater Paris Basin, notably at Etretat, Seine-Martime, Upper Normandy; and Meusnes, Noyers, and Couffy in Loir-et-Cher. Flint occurs at Hegoland Island and Eckernförde Bay near Eckernförde, Schleswig-Holstein, Germany; Fosse de Novale at Rosatti de Sotto and Igna in Vincenza Province, Veneto, Italy; Gjerrid Bay, Norddjors in Midtjylland Region and Hov in Northern Jutland, both in Denmark; Alfarp, Valencia, Spain; and Kinkenbug-Gravenvoeren in Limburg Province and the Spiennes mines at Obourg in Hainaut Province, both in Belgium. Other sources are in Śródborze, Ożarów, Opatów, Świętokrzyskie, Poland; Lägarn in the Jura Mountains, Zurich, Switzerland; and Valkenburg, Limburg, Netherlands. In Israel, flint is found the Jerusalem and Haifa districts.

JEWELRY & DECORATIVE USES

The uses of flint throughout history have been primarily functional, although flint also serves as a gemstone. Polished flint amulets have been recovered from 6,000-year-old cultural sites in the

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Middle East; polished flint bracelets have been found in 5,000-year-old Egyptian tombs. Today, multicolored flint is shaped and polished into cabochons and beads for use in jewelry; it is also tumbled and drilled to make beads for stringing into necklaces and bracelets. Flint with attractive colors and patterns is the preferred medium for flint-knappers, who flake it into arrowhead and spear-point forms for display purposes.

HISTORY & LORE

Flint was one of the first mineral materials to be collected and utilized in Paleolithic times. Archaeologists have recovered flaked flint tools from 2.1-million-year-old, African cultural sites. Flint's functional value is due to its conchoidal fracture (see "Flint: An In-Depth Look") that enables it to be worked or flaked into tools, scrapers, awls, and points for weapons. Flint was one of the earliest trading commodities. By Neolithic times, roughly 10,000 years ago, flint was being systematically mined in many parts of Western Europe, Africa, and North America. Archaeologists have recovered flint artifacts from prehistoric cultural sites worldwide.

Because iron sparks when struck with flint, flint has served as a "fire-starter" since approximately 600 B.C. in virtually all cultures with access to iron. Due to its sparking ability, flint has long been associated with thunder and lightning, and was sometimes used as a talisman to protect against these natural phenomena. Medieval alchemists believed that flint contained the energy of the sun and sought ways to release this energy as heat and light. Many medieval Europeans believed that flint prevented nightmares and provided protection while sleeping. Flint's informal names include "thunder stone," "fire stone," "spark stone," and "nightmare stone." The word "flint," which stems from the Old High German *flins* meaning "pebble" or "hard stone," entered the English language prior to the 12th century A.D. Many North American native cultures used flint in ceremonial rites.

Until the late 1700s, the chemical nature of flint was unknown and it was thought to be its own mineral species. When Swedish chemist Torbern Olaf Bergmann (1735-1784) was studying quartz in 1780, he discovered a chemical similarity between quartz and chalcedony, although he still considered them as separate species. Because Bergmann failed in his attempts to decompose microcrystalline silica, he concluded erroneously that chalcedony was a chemical element. This idea persisted until 1824 when Swedish chemist Jöns Jacob Berzelius (1779-1848) succeeded in decomposing both macrocrystalline and microcrystalline quartz into their two elemental components, oxygen and a new, semimetallic element that he named silicon. After realizing that all forms of silica consisted of silicon dioxide and were thus varieties of the same mineral species, scientists then began to classify quartz types by crystal size. By the mid-1800s, mineralogists understood that flint was an impure form of chalcedony that occurred primarily in formations of limestone and chalk.

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Modern metaphysical practitioners believe that flint is a stone of power and intensity that joins the spiritual realm with the physical world, helps to ground flighty perceptions in reality, and enhances self-discipline, analytical abilities, emotional stability, and physical and intellectual strength.

In 1965, the Ohio General Assembly adopted Flint Ridge flint as Ohio's official state gemstone in recognition of its beauty, importance to prehistoric Native American cultures, and commercial significance during the 1700s and 1800s (see "About our Specimens"). Research into the chemical and physical nature of flint continues today (see "Flint: An In-Depth Look").

TECHNOLOGICAL USES

Flint played vital roles in technological advancement in both prehistoric and more recent times. Throughout the Stone Age, various forms of chalcedony, due to abundance, hardness, durability, and conchoidal fracture, were invaluable mineral resources that were fashioned into pointed and edged weapons and tools. The ability to mine other mineral resources, including copper ores at the beginning of the Copper and Bronze ages, was partially due to the availability of hard, durable digging tools and hammers that had been fashioned from flint and other types of chalcedony.

In ancient Rome, large, flint "cobbles" (crushed rocks) served as a durable building material. The Romans built walls of flint cobbles set in mortar. By the 14th century A.D., "flushwork" masonry, which utilized flint cobbles with flaked, flat surfaces, had become popular throughout Western Europe. Flushwork flint masonry remained popular until it was replaced by brick masonry in the early 1600s. Many examples of flushwork flint masonry can still be seen in Europe today.

Because iron sparks when struck with flint, iron-flint tool combinations called "fire-starters" were used by all cultures with access to iron. Iron-flint sparking mechanisms assumed even greater importance following the introduction of firearms in the late 1300s. Initially, early matchlock and wheel-lock firearms employed sparking devices of pyrite [iron disulfide, FeS₂] and iron. When struck by iron, the pyrite surface shattered, breaking its iron-sulfur bonds and releasing heat energy in the form of sparks.

Far more reliable were the flintlock rifles that appeared in Germany about 1570. These employed shaped flints that were firmly attached to spring-loaded metal arms. When the trigger was depressed, the arm moved forward, striking the flint against an iron plate to produce a shower of sparks that was directed through a touch hole to ignite the gunpowder within the weapon's barrel. In flint-iron sparking, the hard flint shatters the surface of the iron, creating tiny metal particles that oxidize instantly in atmospheric oxygen to release energy as a shower of sparks. Unlike pyrite, a single flint would suffice for 50 or more shots before needing

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replacement. Mining flint and working it into precisely shaped “gunflints” became an important industry in England and France. The largest English gunflint manufacturer of the late 1700s, the Brandon Gunflint Company of London, had 130 workers who produced one million gunflints monthly for worldwide export. During the same period in France, 800 workers produced 30 million gunflints each year. Gunflints were a major trading commodity until percussion firing caps replaced flint-iron firing mechanisms in the 1830s.

Flint was also used on “threshing sledges” in many European agricultural areas. Threshing sledges consisted of heavy boards turned up at the front end and studded on the bottom with hundreds of sharp pieces of flaked flint. Draft animals pulled these sledges in circles over grain that had been piled on cobblestone floors. The flint separated the grain from its husks in preparation for winnowing. Threshing sledges, which appeared as early as 3000 B.C., remained in limited use in some Mediterranean areas until the 1940s.

Flint has no modern technological uses. The “flint” used in modern cigarette lighters, welding strikers, sparkers, and survival-kit fire-starter devices is not natural flint but ferrocerium, an alloy of iron and the rare-earth metal cerium. When scraped against any hard, edged material, ferrocerium creates sparks that are much hotter than those produced with flint and steel. More than 1,000 tons of ferrocerium are manufactured worldwide each year.

FLINT: AN IN-DEPTH LOOK

Before taking an in-depth look at flint, it’s important to clarify its somewhat confusing nomenclature. Flint is a type of chert, which is a subvariety of chalcedony, the microcrystalline variety of quartz. Quartz, with its crystalline structure and definite chemical composition, is a mineral; chalcedony, which lacks a fixed chemical composition, is not a mineral but a variety of quartz. Chalcedony’s many subvarieties include agate, jasper, chert, and flint. The gemstones agate and jasper are basically pure chalcedony, while chert and flint are impure forms which, because of their variable compositions, are classified as rocks. The terms “flint” and “chert” overlap somewhat and are often used interchangeably. In precise geological usage, flint is a type of chert that occurs specifically in limestone or chalk formations; in its lay usage, flint is a higher-grade, finer-grained, and more homogenous form of chert.

Recent investigations into flint’s composition and structure indicate that it consists mostly of chalcedony, along with traces of water, calcite [calcium carbonate, CaCO_3], such impurities as carbon, various oxides and hydroxides of iron, and mogánite [hydrous silicon dioxide, $\text{SiO}_2 \cdot 3\text{H}_2\text{O}$].

Flint’s most important physical property is its conchoidal fracture. Mineral fracture is described in such terms as uneven, hackly, splintery, irregular, and conchoidal. Visually distinctive and readily identifiable, conchoidal fractures are a diagnostic feature of all forms of quartz.

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Conchoidal fracturing is the mechanical basis of flaking, a skill and an art originated by Paleolithic stoneworkers that is still practiced by flint-knappers today. Conchoidal fractures appear as smoothly curving, concave breaks that are similar to the inner surfaces of bivalve mollusk shells. The word “conchoidal” stems from the Greek *konchoeidēs*, meaning “like a mussel.”

The conchoidal-fracturing process begins when quartz is struck with a sharp-edged or pointed object. Deformation or fracturing initiates at the point of impact and is accompanied by a shock wave of mechanical energy that radiates through the quartz. The direction of the radiating energy is controlled by the direction of the impact. When a flint-knapper strikes quartz, the direction of both the fracture and the shock wave progresses through the quartz at an angle slightly declined from the surface. Almost instantaneously, the fracturing of the quartz absorbs part of the shock-wave energy. As this energy decreases, the shock wave exerts its greatest pressure toward the direction of least resistance, thus “steering” the fracture back toward the surface. An impact of the proper energy, direction, and duration displaces a flake and leaves behind a conchoidal depression in the surface of the quartz. Precise control of impact direction, energy, and duration is the key to success in flint-knapping.

ABOUT OUR SPECIMENS

Our flint specimens are from Flint Ridge, a low escarpment in Hopewell and Franklin townships in Muskingum and Licking counties in southeastern Ohio. This area is about 40 miles east of Columbus, the state capital, and just north of Interstate 70 in gently rolling farm country. Among Ohio’s many flint sources, Flint Ridge is the largest and most famous. All Ohio flint deposits occur in limestone formations that are between 440 and 300 million years in age. Flint Ridge is part of the Vanport Limestone formation, which was deposited by shallow seas during the early Pennsylvanian Period some 320 million years ago.

Known as the “Great Indian Quarry of Ohio,” Flint Ridge is an eight-mile-long vein of high-quality flint with hundreds of ancient quarry pits and “workshop” sites. These pits range from 12 to 80 feet in diameter and 3 to 20 feet in depth. Flint Ridge flint exhibits an unusually bright multicoloration. Its most prominent colors are white and light gray, but the most attractive and interesting specimens are multicolored, with mixed shades of reds, yellows, browns, and black.

Ohio's native cultures fashioned Flint Ridge flint into spear points, arrowheads, scrapers, awls, and knives. The Hopewell Culture, which existed from 100 B.C. to 500 A.D., used this flint extensively to fashion small knives that archaeologists call “bladelets.” Flint Ridge flint was widely traded among various Native American cultures and has been recovered from cultural sites as distant as the Atlantic Coast, the Gulf Coast, and the Mississippi River. European settlers later fashioned Flint Ridge flint into fire-starters, gunflints, and large, flat stones for grinding grain called “burhstones.”

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The first study of Flint Ridge was conducted in the 1880s by Charles Smith, who published his findings in the 1884 Smithsonian Institution annual report and his 1902 book *Archaeological History of Ohio*. William C. Mills, former Curator of Archaeology for the Ohio Historical Society (now the Ohio History Connection), conducted the first scientific study of Flint Ridge in 1920 and surveyed and excavated many quarry pits. Mills confirmed that the Hopewell Culture had quarried most of the flint and flaked it at nearby workshops into two basic forms: leaf-shaped bifaces (flat pieces of flint worked on both the front and back); and small, cone-shaped cores or blanks for making long, thin bladelets.

In 1933, the Ohio Historical Society established the Flint Ridge State Memorial, which is now listed on the National Register of Historic Places. In 1965, the Ohio General Assembly adopted Flint Ridge flint as Ohio's official state gemstone. Three years later, the state built a museum at the Flint Ridge State Memorial, which now features restored, prehistoric quarries along with exhibits on local geology and the uses of flint.

In 1987, Ohio State University Professor of Anthropology Richard Yerkes performed field studies at the Flint Ridge State Memorial that provided further insight into how the Hopewell people quarried flint and fashioned tools. In 1997, Ohio Historical Society archaeologists excavated new areas along Flint Ridge, recovering several tons of flint tools and flakes.

Today, Flint Ridge flint is shaped and polished into pendants and beads for use in jewelry. Flint-knappers also flake it into spear-point, arrowhead, scraper, and knife forms, which are sold under such names as "Ohio Flint," "Vanport flint," "Hopewell flint," and "Flint Ridge flint."

The Flint Ridge State Memorial and Museum is located on 525 acres at 15300 Flint Ridge Road in Glenford, Ohio. The museum is open from May 1st to October 15th. The grounds, where trails access hundreds of prehistoric flint quarries, are open year-round. The Nethers Farm at 3890 Flint Ridge Road allows rockhounds to collect flint for a \$5.00 fee and payment of 50 cents per pound for removal of specimens.

As you study your specimen of Flint Ridge flint, note its extremely fine grain that takes a superb polish. In your multicolored specimen, the black colors are caused by elemental carbon from organic sources, while the red, yellow, and brown colors are created by such metal oxides and hydroxides as hematite [iron oxide, Fe_2O_3] and goethite [basic iron oxide, $\text{FeO}(\text{OH})$].

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