Chalcedony

Chalcedony (kal SED' uh nee) or (kal-ced-nee) also spelled Calcedony is formed from Silicon dioxide, better known as quartz, and is one of the most abundant minerals on Earth (quartz makes up about 12% of the earth's crust).

Traditionally defined as a fibrous cryptocrystalline variety of Quartz, more recently, it has been shown that much Chalcedony is a mixture of Quartz and Moganite, another Silica mineral.

The term *chalcedony* is derived from the name of the ancient Greek town Chalkedon in Asia Minor, in modern English usually spelled Chalcedon.

Mineralogists divide quartz into two classifications: *crystalline* and *cryptocrystalline,* based on the size of its crystals.

Cryptocrystalline is also called *microcrystalline* quartz.

Due to its distinct crystal formation, crystalline quartz is usually transparent. Rock crystal, amethyst, citrine, and rose quartz are well-known examples of crystalline quartz.

Cryptocrystalline

Cryptocrystalline is a rock texture which is so finely crystalline, that is, made up of such minute crystals that its crystalline nature is only vaguely revealed even microscopically in thin section by transmitted polarized light. Among the sedimentary rocks, agate, chert jasper, and flint are cryptocrystalline. Also a form of diamond, known as carbonado, is cryptocyrstalline.

Volcanic rocks, especially of the acidic type such as felsites and rhyolites, may have a cryptocrystalline matrix as distinguished from pure obsidian (acidic) or tachylyte (basic), which are natural rock glasses. The atoms in cryptocrystalline quartz pack together to form stones that are either opaque or translucent. The atoms take the form of fibers, rather than crystals, and the stones often contain water or air trapped between the layers of fibers.

Some blue and green colors in chalcedony are probably produced in metal-poor layers by the scatter of light due to submicron-sized bubbles. This is one reason why some blues and greens do not stay blue or green when cut. Cutting causes changes in light scatter, loss of water or entrapped air.

The cryptocrystalline quartzes are informally divided into two groups: *jasper* and *chalcedony*. The jaspers are often opaque, while the chalcedonies tend to be transparent. Most mineralogists don't distinguish between the two, simply referring to both as cryptocrystalline.

Chalcedony is found in all 50 States, in many colors and color combinations, and in sedimentary, igneous, and metamorphic rocks.

Chalcedony is a mixture of Quartz and Moganite; morganite is a polymorph of silica occurring in quartz specimens. Morganite is a newly recognized mineral species that may be quite abundant in nature, particularly associated with microcrystalline or cryptocrystalline quartz. It has a crystal structure closely related to that of quartz; essentially that of quartz twinned periodically on the atomic scale.

The semitransparent, translucent, plume or moss color types are "***chalcedony***".

When it is concentrically banded (often in rather wild patterns) it is called by the sub-variety name ***agate***. Agate is rarely transparent.

When it is in flat layers/bands it is called by the sub-variety name ***onyx***.

Note: Many non-banded forms of chalcedony - such as moss agate - are often erroneously called 'agates'. True agate is concentrically banded. Mottled and included chalcedonies are more properly called simply 'chalcedony

Agatized wood is the name given to fossil wood where the replacement of the wood is by chalcedony, but the banding in this case is due to the wood structure - not concentric deposition of the chalcedony - and the material is chalcedony, not true banded agate.

What makes chalcedony colorful?

It is the chemistry of the groundwater; minerals such as manganese, iron, and copper were in the water/mud during the forming process. These minerals give chalcedony a variety of color ranges. Quartz crystals are colorless, but when iron is added to the process the crystals become stained with a yellow or red tint.

The following is a list of minerals and related color hues:
Copper - green/blue
Cobalt - green/blue
Chromium - green/blue
Manganese – pink/purple
Carbon - black
Iron Oxides - red, brown, yellow
Manganese Oxides - black
Silica - white, grey

Chalcedony is one of the cryptocrystalline varieties of the mineral quartz, having a waxy luster. Chalcedony may be semitransparent or translucent and is usually white to gray, grayish-blue, yellow or some shade of brown, sometimes nearly black. Other shades have been given different names.

Moss Agate: Also called **Mocha Stone**, this grayish to milky-white chalcedony contains dark-colored, dendritic branching forms that resemble ferns, moss, or other vegetation. These formations are caused by the inclusion of mainly manganese and iron oxides of inorganic origin. Most moss agates are found as fragments weathered from volcanic rocks and long used for ornamental purposes. Those which have a more plant or feather-like appearance have been called moss or plume agates.

Onyx: This striped, semiprecious variety of agate has black and white alternating bands. Onyx is used in carved cameos and intaglios because its layers can be cut to show a color contrast between the design and the background. Onyx is one of the 12 stones mentioned in the Bible as adorning the breastplate of the high priests.

Sardonyx: This onyx is striped with white and red/brown layers.

Bloodstone: Also called **Heliotrope**, this dark-green variety of chalcedony has nodules of bright-red jasper distributed throughout. Bloodstone was greatly prized in the Middle Ages and was used in sculptures representing flagellation and martyrdom.

Carnelian: light brownish-red to deep transparent or translucent red chalcedony is called Carnelian, which owes its red to color to hematite (iron oxide). It is a close relative of **Sard**, which is browner in color and more opaque. The Greeks and Romans used carnelian in rings and signets.

Chrysoprase: This brittle, translucent form of chalcedony owes its bright, apple green color to the inclusion of nickel silicates or oxides, but heating or prolonged exposure to sunlight causes the color to fade.

Prase: Prase is a dull green, yellowish green, translucent, leek-green variety of the silica mineral chalcedony. It is colored by hornblende fibers and chlorite. Prase has been found at numerous localities.

Plasma: This semi-translucent, micro granular variety of chalcedony occurs in various shades of green, caused by amphibole or chlorite inclusions. *Plasma* is a bright to emerald-green chalcedony that is sometimes found with small spots of jasper resembling blood drops; it has been referred to as blood stone or heliotrope.
Plasma often has nodules of gray quartz or Bloodstone throughout its mass. It has long been used for carvings and mosaics.

Picture Jasper: Because of jaspers unique landscape patterns and wide ranges of colors it is one of the most famous varieties. Picture jasper is a petrified or silicated mud. Looking at its patterns, it isn't hard to visualize mud dripping into gas pockets in molten lava, becoming super-heated and then solidifying into this treasured gemstone. Some of the most treasured gems are those that show a picture that appears to be taken from nature. Oregon's Biggs Jasper is now the most common source. Bruneau Jasper, from Bruneau Canyon, Idaho, used to be the preferred material until you couldn’t get it.

Tiger's Eye: Another famous chalcedony is the "*Tiger's Eye*". This almost legendary mineral has a most interesting and confusing appearance. It is caused by a finely fibrous structure of **Crocidolite Asbestos** that was once present, but has been transformed into Chalcedony through pseudomorphism.

CHALCEDONY		
Chemistry	**Crystal System**	**Hardness**
SiO2	Tetrahedral	7.0 (Mohs' scale)
Cleavage	**Fracture**	**Specific Gravity**
Rhombohedral	Conchoidal	2.65
Color, Transparency, Luster & Streak	**VARIETIES**	
Color: Various shades of purple **Transparency**: Transparent to sub-translucent **Luster:** Glassy	Agate Bloodstone Carnelian Chrysoprase Heliotrope Mocha Stone Moss Agate Onyx Plasma Prase	

Chatoyancy

Chatoyancy is the lustrous, cat's eye effect seen in some cabochon stones, like cat's eye, tiger's eye, and sometimes in other stones, like aquamarine. In chatoyancy, light is reflected in thin bands within the stone. Chatoyant stones are cut in cabochon to maximize the lustrous effect.

Agate

Agate is the most common variety of **chalcedony**, which is a form of quartz. Agate is, in fact, identical with quartz in composition and physical properties. Composed of silicon dioxide (SiO2), it has a hardness of 7, a glassy luster, a conchoidal fracture, and a specific gravity of 2.60.

Most agates occur in cavities of eruptive rocks or ancient lavas. These agates have a banded structure, successive layers being approximately parallel to the sides of the cavity.

During crystallization, the colored bands are not disturbed.

Varieties of agate are characterized by peculiarities in the shape and color of the bands, which are seen in sections cut at right angles to the layers.

Agate is distinguished by having multiple colors. While not usually as rich as crystalline gems, the colors can be quite vivid. Agates are sometimes opaque, but they are frequently translucent, and occasionally completely transparent.

No gemstone is more creatively striped by nature than agate. Each individual agate forms by filling a cavity in host rock. As a result, agate often is found as a round nodule, with concentric bands like the rings of a tree trunk.

The bands sometimes look like eyes, sometimes-fanciful scallops, or even a landscape with dendrite trees. This common semiprecious variety of chalcedony is conspicuously color-banded with other minerals in successive layers. It occurs in bands of varying color and transparency in cavities of eruptive rocks or ancient lava. Agates come in many varieties themselves.

Formation and Characteristics of Agates

Agate forms when gas bubbles trapped in solidifying lava become filled with alkali and silica-bearing waters, which coagulate into a gel. The alkali attacks the iron in the surrounding lava, and bands of the resulting iron hydroxide are created in the gel, which loses water and crystallizes, leaving the bands intact. Many agates, when cut in cross-section, reveal striking forms.

Most agates occur as nodules in eruptive rocks or ancient lavas where they represent cavities originally produced by the disengagement of vapour in the molten mass which were then filled, wholly or partially, by siliceous matter deposited in regular layers upon the walls. Such agates, when cut transversely, exhibit a succession of parallel lines, often of extreme tenuity, giving a banded appearance to the section. Such stones are known as banded agate, riband agate and striped agate.

In the formation of an ordinary agate, it is probable that waters containing silica in solution -- derived, perhaps, from the decomposition of some of the silicates in the lava itself -- percolated through the rock and deposited a siliceous coating on the interior of the vapour-vesicles. Variations in the character of the solution or in the conditions of deposit may cause corresponding variation in the successive layers, so that bands of chalcedony often alternate with layers of crystalline quartz. Several vapour-vesicles may unite while the rock is viscous, and thus form a large cavity which may become the home of an agate of exceptional size.

The first deposit on the wall of a cavity, forming the "skin" of the agate, is generally a dark greenish mineral substance, like celadonite a mica group mineral, delessite a magnesium rich form of chamosite or "green earth," which is rich in iron probably derived from the decomposition of the augite in the mother-rock. Augite is a calcium sodium magnesium iron aluminium silicate.

This green silicate may give rise by alteration to a brown oxide of iron limonite, a hydrated iron(III) oxide-hydroxide of varying composition, producing a rusty appearance on the outside of the agate-nodule. The outer surface of an agate, freed from its matrix, is often pitted and rough, apparently in consequence of the removal of the original coating. The first layer spread over the wall of the cavity has been called the "priming," and upon this base zeolitic mineral may be deposited.

Many agates are hollow, since deposition has not proceeded far enough to fill the cavity, and in such cases the last deposit commonly consists of quartz, often amethyst, having the apices of the crystals directed towards the free space so as to form a crystal-lined cavity, or geode.

On the disintegration of the matrix in which the agates are embedded, they are set free. Being a siliceous material, which is extremely resistant to the action of air and water, they remain as nodules in the soil and gravel, or become rolled as pebbles in streams.

Chemical solutions of minerals in the silica gel are responsible for the agate's vivid colors.

Pseudomorph

Pseudomorphism is the act of one mineral chemically replacing another.

Types of Agate

A Mexican agate, showing only a single eye, has received the name of "cyclops agate." Included matter of a green, golden, red, black or other colour or combinations embedded in the chalcedony and disposed in filaments and other forms suggestive of vegetable growth, gives rise to dendritic or moss agate (named varieties include Maury Mountain, Richardson Ranch, Sheep Creek and others). **Dendritic** agates have beautiful fern like patterns on them formed due to the presence of manganese and iron ions. Other types of included matter deposited during agate-building include sagenitic growths (radial mineral crystals) and chunks of entrapped detritus (such as sand, ash, or mud). Occasionally agate fills a void left by decomposed vegetative material such as a tree limb or root and is called limb cast agate due to its appearance.

Turritella agate is formed from fossil Turritella shells silicified in a chalcedony base. Turritella are spiral marine gastropods having elongated, spiral shells composed of many whorls. Similarly, coral, petrified wood and other organic remains or porous rocks can also become agatized. Agatized coral is often referred to as Petoskey agate or stone. Certain stones, when examined in thin sections by transmitted light, show a diffraction spectrum due to the extreme delicacy of the successive bands, whence they are termed rainbow agates. Often agate coexists with layers or masses of opal, jasper or crystaline quartz due to ambient variations during the formation process.

Other forms of agate include carnelian agate (chalcedony usually exhibiting redish hues), Botswana agate, blue lace agate, plume agate (such as Carey, Graveyard Point, Sage, St. Johns, Teeter Ranch and others), tube agate (with visible flow channels, golden swril agate?), fortification agate (which exhibit little or no layered structure), fire agate (which seems glow internally like an opal) and Mexican crazy-lace agate (which exhibits an often brightly colored, complex banded pattern).

Chert

Chert is a fine-grained silica-rich cryptocrystalline sedimentary rock that may contain small fossils. It varies greatly in color from white to black, but most often manifests as gray, brown, grayish brown and light green to rusty red; its color is an expression of trace elements present in the rock, and both red and green are most often related to traces of iron (in its oxidized and reduced forms respectively). Jasper is basically chert which owes its red color to iron inclusions.

Chert outcrops as oval to irregular nodules in greensand, limestone, chalk, and dolostone formations as a replacement mineral, where it is formed as a result of diagenesis.

Diagenesis is any chemical, physical, or biological change undergone by sediment after its initial deposition and during and after lithification. Lithification is the process whereby sediments compact under pressure. It also occurs in thin beds, when it is a primary deposit. Thick beds of chert occur in deep geosynclinal deposits. **Geosyncline** refers to a thick pile of sedimentary rocks that were deposited in a subsiding marine basin and subsequently compressed, deformed, and uplifted into a mountain range with attendant volcanism and plutonism. The banded iron formations of Precambrian age are composed of alternating layers of chert and iron oxides.

Chert is generally considered to be less attractive and more common than flint, although the two materials are closely related. In geological terms flint and chert are the same, with the term flint referring to chert found in chalk.

Flint

Flint is also a variety of chalcedony. Flint (or flintstone) is a hard, sedimentary cryptocrystalline silicate rock with a glassy appearance. Flint is usually dark-grey, blue, black, or deep brown in color. It occurs chiefly as nodules and masses in sedimentary rocks, such as chalks and limestones.

The exact mode of formation of flint is not yet clear or agreed but it is thought that it occurs as a result of chemical changes in compressed sedimentary rock formations, during the process of diagenesis. One theory is that a gelatinous material fills cavities in the sediment, such as holes bored by crustaceans or mollusks and that this becomes silicified. This could certainly explain the complex shapes of flint that are found.

Jasper

Jasper is an opaque, impure Chalcedony, traditionally thought of as red. It also comes in pinks, yellows, greens, browns, and grayish blues. Association with other minerals gives jasper nice bands and patterns. In the ancient world Jasper was a favorite gem. Jasper is usually named according to its pattern.

Picture jasper, ribbon jasper, orbicular jasper, abraciated jasper. Jasper is found worldwide**.** *Onyx, prase, sard, sardonyx,* and *tiger's eye* are usually classified as jaspers. Jasper is an opaque, solid or patterned variety of cryptocrystalline quartz, which consists of very tiny quartz crystals colored by various mineral impurities.

This mineral breaks with a smooth surface, and is often used for ornamentation or as a gemstone. It can be highly polished and is used for vases, seals, and at one time for snuff boxes. When the colors are in stripes or bands, it is called *striped* or *banded* jasper. Jaspilite is a banded iron formation rock that often has distinctive bands of jasper. The Egyptian pebble is brownish-yellow jasper.

More usually, jasper exhibits one or more type of pattern or variation from formation processes. Most often, variations rise from flow patterns inherent in the precursor sediment or volcanic ash saturated with silica to form jasper, yielding bands, apparent channels, or eddying swirls in the rock.

The names of various jaspers can come from their color: bloodstone, green, lemon; from their pattern: orbicular, poppy, leopard skin, landscape, Picasso; or from a place name: Morrisonite, Mookite.

All jaspers take an excellent polish, are trouble free to care for, and hardy enough for all jewelry uses. These stones are usually cabbed, sometimes carved, and seldom faceted.

Jewelry use of jaspers goes back into the early history of civilization. Various forms of this material are also frequently made into decorative objects, such as ashtrays or bookends. Jaspers are found all over the world, with certain colors or patterns unique to particular locales. Most bloodstone comes from India, all Mookaite from Australia.

The hue or saturation of color may vary across the material. Jasper may be permeated by a crystal **dendrite.**

Picture Jasper Localities

Some of the better known Picture Jaspers come from places like:

Bruneau Jasper ,Bruneau Canyon, Idaho

Wild Horse, Classic Owyhee and Rocky Butte picture jaspers are from Owyhee County in southern Idaho and part of Eastern Oregon

Fryite from Lewison, Idaho.

Morrison Ranch Picture Jasper (Morrisonite) high quality jasper found in the Owyhees of Oregon

Willow Creek Jasper, from the Willow Creek Mine fifteen miles North of Boise, Idaho
Blue Mountain Picture Jasper, from Nissa Oregon

There are many more types available like chicken track, arroyo, Burrow Creek, Cripple Creek. Not to mention the many foreign varieties.

Dendrite

A dendrite is a crystal that develops with a typical multi-branching *tree-like* form. Dendritic crystal growth is very common and illustrated by snowflake formation and frost patterns on a window. Dendritic crystallization forms a natural fractal pattern. Some dendritic minerals provide the appearance of vegetative growths.

The Jasper may have been fractured and/or distorted after formation, later re-bonding into discontinuous patterns or filling with another material. Heat or environmental factors may have created surface rinds (such as varnish) or interior stresses leading to fracturing.

Picture jaspers simultaneously exhibit several of these variations (such as banding, flow patterns, dendrites or color variations) resulting in what appear to be scenes or images in a cut section (as in Biggs, Deschutes, Owyhee, Poppy and other named types).

Spherical flow patterns produce a distinctive orbicular appearance (porcelain jaspers such as Blue Mountain, Bruneau and Willow Creek). Complex mixes of impurities produce wild color variations (as in McDermit jasper). Healed fractures produce brecciated jasper (such as Canyon Creek).

Breccias

Breccia is derived from the Latin word for "broken," is typically a rock composed of angular fragments in a matrix that may be of a similar or a different material.

Sedimentary breccias

Sedimentary breccias are a type of Clastic rocks which refers to rocks formed from fragments of pre-existing rock. Clastic sedimentary rock which are composed of angular to sub angular, randomly oriented clasts of other sedimentary rocks. They are formed by submarine debris flows, avalanches, mud flow or mass flow in an aqueous medium. Technically, turbidites are a form of debris flow deposit and are a fine-grained peripheral deposit to a sedimentary breccia flow.

The other derivation of sedimentary breccia is as angular, poorly sorted, very immature fragments of rocks in a finer grained groundmass which are produced by mass wasting. These are, in essence, lithified colluvium. Thick sequences of sedimentary (colluvial) breccias are generally formed next to fault scarps in a graben. A graben is a depressed block of land bordered by parallel faults.

In the field, it may at times be difficult to distinguish between a debris flow sedimentary breccia and a colluvial breccia, especially if one is working entirely from drilling information. Sedimentary breccias are an integral host rock for many Sedimentary exhalative deposits (SEDEX ore deposits).

A conglomerate by contrast is a sedimentary rock composed of rounded fragments or clasts of pre-existing rocks. Both breccias and conglomerates are composed of fragments averaging greater than 2 mm in size. The angular shape of the fragments indicates that the material has not been transported far from its source.

Breccias indicate accumulation in a juvenile stream channel or accumulations due to gravity erosion. Talus slopes may become buried and the talus cemented in a similar manner.

Breccia nomenclature

Breccias can be classified by their constituents, mode of occurrence and by their size, the types of clasts, source of clasts, and so forth. Several textural terms are used to describe the morphology and textural variations observed in breccias.

Milling

Breccias which are formed by injection of a slurry (be it as a hydro fracture breccia or, more usually, a volcanic or intrusive breccia) often show evidence of rounding of the clasts. With a sedimentary rock this may be called a conglomerate, except when the breccia is discordant with former lithology. For an intrusive breccia, erosion and transport in a watercourse cannot be invoked to explain rounding.

Breccias of this type which are rounded are said to be *milled*, a process by which the breccia matrix grinds the larger clasts and rounds them off. This has been observed to have occurred in some hydrothermal breccias.

Autobrecciation

Autobrecciation is the process by which a rock's mechanism of formation causes it to become broken and to include its broken fragments within itself.

Fault breccias

Fault breccias result from the grinding action of two fault blocks as they slide past each other. Subsequent cementation of these broken fragments may occur by means of mineral matter introduced by groundwater.

Igneous breccias

Igneous clastic rocks can be divided into two classes

Broken, fragmental rocks produced by intrusive processes, usually associated with plutons or porphyry stocks.

Broken, fragmental rocks associated with volcanic eruptions, both of lava and pyroclastic type.

Volcanic breccias

Volcanic pyroclastic rocks are formed by explosive eruption of lava and any rocks which are entrained within the eruptive column.
This may include rocks plucked off the wall of the magma conduit, or physically picked up by the ensuing pyroclastic surge. Lavas, especially rhyolite and dacite flows, tend to form clastic volcanic rocks by a process known as autobrecciation.

This occurs when the thick, nearly solid lava breaks up into blocks and these blocks are then reincorporated into the lava flow again and mixed in with the remaining liquid magma. The resulting breccia is uniform in rock type and chemical composition.

Lavas may also pick up foreign rock fragments, especially if flowing over unconsolidated rubble on the flanks of a volcano, and these form volcanic breccias.

The volcanic breccia environment is transitional into the plutonic breccia environment in the volcanic conduits of explosive volcanoes, where lava tends to solidify and may be repeatedly shattered by ensuing eruptions. This is typical of volcanic caldera settings.

Intrusive breccias

Clastic rocks are also commonly found in shallow subvolcanic intrusions such as porphyry stocks, granites and sometimes kimberlite pipes, where they are transitional with volcanic breccias.

Intrusive rocks can become brecciated in appearance by multiple stages of intrusion, especially if fresh magma is intruded into partly consolidated or solidified magma.
This may be seen in many granite intrusions where later aplite veins form a late-stage stock work through earlier phases of the granite mass.

Aplite is the name given to intrusive rock in which quartz and felspar are the dominant minerals. Aplites are usually very fine-grained, white, grey or flesh-colored, and their constituents are visible only with the help of a magnifying lens.

When particularly intense, the rock may appear as a chaotic breccia.
Impact breccias are thought to be diagnostic of an impact event such as an asteroid or comet striking the earth, and are usually found at impact craters.

Impact breccias

A fairly rare form of breccia is formed during meteorite impact. This is composed primarily of ejecta; clasts of country rock, melted rock fragments, tektites (glass ejected from the impact crater) and exotic fragments, including fragments derived from the impactor itself.

Impact craters also form a basal breccia in the floor of the crater formed by a combination of shattering due to the force of the impact and the subsequent cooling and melting of the rocks, which may rise upwards to form a small mound in the centre of the crater.

Identifying a clastic rock as an impact breccia requires recognizing shatter cones, tektites, spherulites, and the morphology of an impact crater, as well as potentially recognizing particular chemical and trace element signatures, especially osmium and iridium.

Hydrothermal breccias

Hydrothermal breccias are usually formed by hydro fracture of rocks by highly pressured hydrothermal fluids. They are typical of the epithermal ore environment and are intimately associated with intrusive-related ore deposits.