Agate, Jasper, Opal, Chert and other Related Definitions
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The author challenges the European definition of agate, jasper, and opal as cryptocrystalline quartz. Instead, the author defines them defined as:

Amorphous Silicas: The agates, jaspers, and opals are substantially amorphous and are best defined forming with silica gel chemistry. Their localities, conditions of formation, and structures can be predicted by silica gel chemistry.

C-S-H Gels: The agates, jaspers, and opals form as calcium-silica-hydroxyl gels. Carbonate and silica in hydrated systems form these rocks. It is the chemical nature of the interaction of carbonate and silica that makes agates and the larger group of calcium-silicate minerals banded.

N-S-H Gels: Sodium-silica-hydroxyl gels such as magadiite occur in hypersaline systems. Agates, jaspers, and opals cannot form in environments that are hypersaline. These systems precipitate quartz and silicate minerals, instead.

Rocks: Agates, jaspers, and opals are rocks that at a mineralogical level form in clay-zeolite-silica-hydrate systems. The clays and zeolites accumulate the alumina and the silica concentration we identify as agate. By far, the number one source of these rocks is zeolitized volcanic ash. This also means that by far, the number one source of agates, jaspers, and opals is volcanic ash, not lava voids. The author estimates average travel distance of silica to make agate is 3 inches. They do not form from weathering or groundwater transport.

Agate: Any silica rock containing at least some fibrous silica layers. A mostly amorphous silica rock consisting of <3% sulfides, <3% salts (typically <0.7%), <5% iron compounds. The lack of iron tends to make agates translucent, but this is not an important criterion as agate can be translucent, opaque, or mixed. They contain various amounts of clays and zeolites. Clay inclusions can be expansive (bentonite, making plumes) or non-expansive (illite, making microspheres). Only illite-bearing agate can form strongly banded agate; bentonite agate cannot. The minimum silica content for specimens is hard to determine directly, but their source rocks indicate they should generally be more than 40% silica. Only forms in alkaline systems.

Jasper: An amorphous silica rock consisting of clays and silica. The clay is often illite, a non-expansive clay. It has 5-25% iron compounds. Less, it is an agate. More it is a banded iron formation rock, an iron ore. All jasper appears to have some translucent silica regions at a microscopic level but we call it jasper-agate only if the agate is visible to the naked eye. Being opaque is not sufficient; the rock must contain sufficient iron to make the rock red, yellow, green, purple, or black. This means that non-iron bearing silica rocks that are opaque are not jasper. Those are often pyroclastic rocks, rhyolite, siliceous sediments, etc. Only forms in alkaline systems.

Chalcedony: Hydrothermal and volcanic melt exsolution silica deposited in rhyolitic rock fractures and vugs. Often formed as vein silica. Weakly banded perhaps due to presence of oxides. Has only two colors, white and pink. Thick pink specimens appear lavender. Translucent. Since this is a niche geologic silica occurrence, the author does not define this as the parent term over agate, and instead calls agate the parent term.

Opal: An amorphous silica consisting of clays and silica. The clay is presumed to be illite. It generally forms as a hydrate byproduct of agate and jasper formation, residing as a crust coating nodules of those rocks. It is commonly green from the clay celadonite, although some identify it as the clay nontronite. Frequently formed on the outside of nodules, with oxygen exposure, it commonly has manganese dendrites. Unlike the others, opal can form in acid and alkaline systems.

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Chert: An amorphous silica rock consisting of clays and silica. This is a silica that formed in saline systems up to 5% salt, shutting down the normal inclusions and banding found in agates. The silica source for cherts are volcanic ash deposited with carbonates in ocean sediments from volcanic eruptions. Unlike agates, all cherts form by accretionary deposition, forming nodules. The cryptocrystalline description of chert comes from microspheres of included cristobalite.

Chert-Agate: An oolitic chert (from cristobalite) where aggregations of concentric banding merge to create localized agate banding centers.

Flint: An archeological term for chert that can be used to start fires, therefore it contains marcasite and can be considered darker than chert due to the marcasite.

Figure 1. The Classical European model of agate formation.
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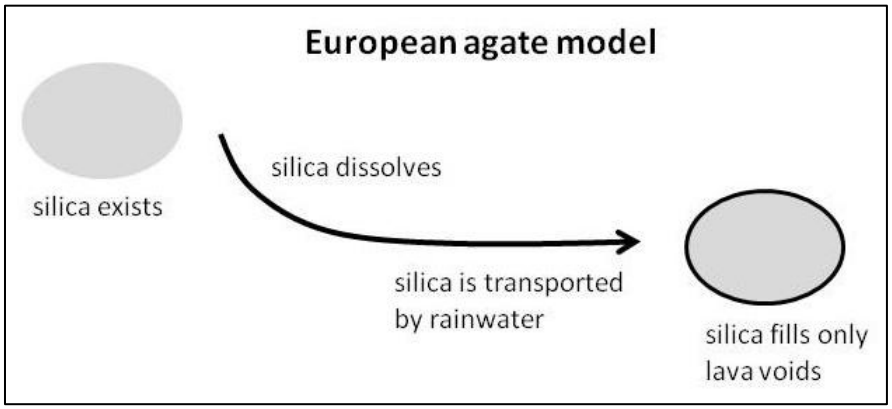

Figure 2. New--A geochemical silicate reaction model of agate formation
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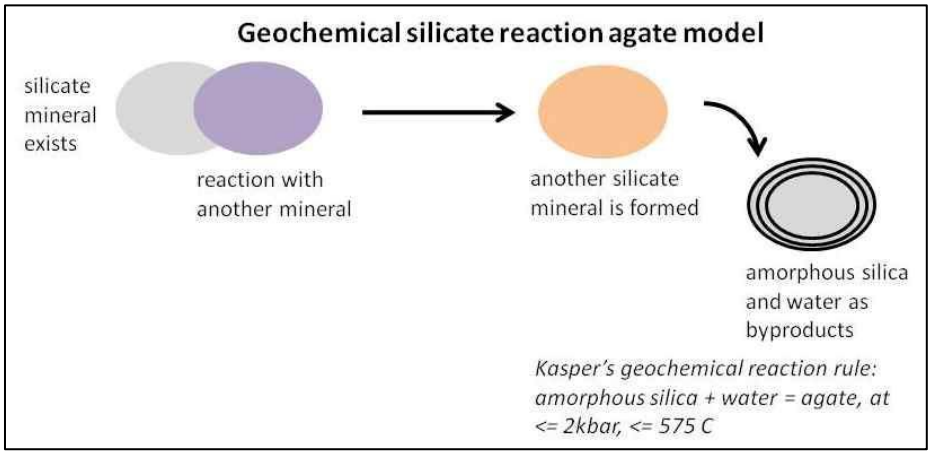

Kasper's Reaction Rule: All agate must form under the 2kbar pressure ceiling, and 575 C temperature wall.