Disorderly Opal

Minerals are crystalline solids, having regular long-range arrangements of their atoms repeating predictably in three dimensions. But there are a few substances, called “mineraloids,” which have mineral-like occurrences, properties and consistency of composition but not a long-range crystalline structure. One of these is opal. Opal, a hydrated form of silica with variable amounts of included water. It is often described as amorphous (literally “without form”). Recent studies, have clarified opal’s atomic nature, subdividing it into categories such as “opal-CT” that read like an alphabet soup. Recent articles, such as one on the origin of thunder eggs from Colorado (Kile, 2002), use these terms, so it is worth-while finding out what they mean.

Opal’s lack of long-range atomic structure is verified by its response to x-rays. When x-rays pass through a mineral, they are affected by that mineral’s internal atomic structure. When the x-rays emerge, they make a pattern that is recorded on film or graph paper and reveals the mineral’s internal symmetry. In opal, the pattern that emerges is diffuse and not very regular. But “not very regular” is not the same as “random.” Some opals do show a short-range arrangement of their atoms. This allows subdivision of opals into categories based on the type and extent of this order/disorder. The pattern in opal apparently consists of small spheres or chains of linked Si and O atoms. These structures are surrounded by more silica in a gel-like matrix. The arrangement of the spheres is similar to that of some high temperature forms of SiO2 - namely cristobalite and tridymite. The type of material found in the opal is the key to the alphabet soup.

Opal A is opal that is truly amorphous, having little if any arrangement of atoms. Much gem opal is of this variety. Opal AG is the least structured, being all amorphous gel (= AG. Get it?). Opal AN has a vague network structure in the gel. A lot of hyalite opal, thought to form as vapor condensate, is of this type.

Opal CT has intermixed tridymite and cristobalite structure along with unstructured gel. It gives broad x-ray patterns, so at least is “aspiring” to true crystallinity. Lots of common opal and some gem opal is of this variety. Within this is Opal CTm (massive structure), opal CTp (platy structure) and opal CTl (fibrous structure). In case you are wondering where the “l” came from, (or what the “l” is going on) this fibrous structured opal has been termed “lussatite.”

Opal C has a pattern dominated by a diffuse structure resembling cristobalite. Agate at the base of Uruguay amethyst geodes has some of this, so many of you have specimens of this.

Over time opal becomes less disorderly. Its structure is not one that will last, as the atoms are more stable when arranged in a real crystal structure. Burial with moderate temperatures and pressures speed the breakdown process. Eventually opal passes form Opal A to Opal CT to fine-grained quartz or chalcedony. Much chert was probably common opal at one time or another. This nomenclature allows mineralogists who study opal to focus their attention of various types. Each type of opal has its own conditions of formation, and its orderly to disorderly pattern is often a window to those geological conditions.

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References:

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