ORIGIN OF CHALCEDONY NODULES IN RHYOLITE FROM THE PELONCILLO MOUNTAINS, Hidalgo County, New Mexico

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The origin of agate and chalcedony nodules has always been something of an enigma to mineralogists, as well as to the general public. Although the general concept of their formation has been fairly well understood, the precise details involved in the process of their formation at each particular locality have tended to be more difficult to explain.

A particularly intriguing occurrence of chalcedony nodules has recently been recognized in mid-Tertiary silicic volcanic rocks near the Arizona-New Mexico border in southwestern Hidalgo County, New Mexico. The occurrence is in the vicinity of Clanton Draw and Geronimo Pass, in the Coronado National Forest. The nodules formed within a late Oligocene, high-silica rhyolite lava flow (Rhyolite of Clanton Draw) along the north margin of the Geronimo Trail cauldron (McIntyre, 1988; Erb, 1979; and Charles Bryan, personal communication, 1995).

The chalcedony nodules were recently noticed by Charles Bryan (University of New Mexico) in the course of field work. Ramon S. DeMark and Brian Huntsman learned about the occurrence from Bryan. The nodules range in size from about an inch to 10-12 inches in diameter. They are typically hollow, and only partially fill somewhat angular, irregular-shaped cavities in the host rhyolite. The chalcedony lining making up the nodules is typically from 0.5 to 1 cm thick. Some nodules are flattened or elongated parallel to the direction of flow banding in the rhyolite; others are subspherical. Most nodules are found loose, as “float” pieces, usually still partially attached to pieces of the host rhyolite.

A few occur as loose nodules totally free of rhyolite matrix, and some are seen embedded in rhyolite boulders or outcrops. An unusual feature of the nodules is the way the chalcedony appears to have "oozed" out of the interior surface of the cavity in rhyolite; lobes of chalcedony surround, but usually do not completely close off, the opening of the host cavity. Rarely, completely closed, hollow nodules have weathered out of the rhyolite; some such nodules have thin enough walls and contain a large enough void to float on water.

The chalcedony is fibrous with a radiating microstructure. Fibers are length-fast (elongated perpendicular to the c-axis), as has been reported to be the case for most agate and chalcedony. The color ranges from pale pink to milky-white to colorless; typically, the later-formed material (toward the interior of the rock cavity) is more cloudy. The chalcedony fluoresces bright green under short-wave UV light, typical of hydrous silica containing trace amounts of the uranyl (UO₂²⁺) ion. The last-formed layers of chalcedony tend to be the most brightly fluorescent, but some of the earliest-formed layers (adjacent to the host rhyolite) also fluoresce brightly. The most cloudy/milky chalcedony usually shows little fluorescence. Fluorescent banding in the layers helps to trace growth patterns in the chalcedony.

Cross-sectioning reveals that the early-formed chalcedony in the interior of the nodules has grown radially from nucleation sites on the rock cavity walls, but later chalcedony growth appears to have progressed outward toward the cavity opening, parallel to the cavity walls. Thin, green-fluorescent chalcedony-filled fractures in the surrounding rhyolite appear to mark pathways by which silica-bearing water was carried into the cavities. Toward the interior of the cavities, some of the last-formed fibrous chalcedony grades into a layer composed of minute, euhedral drusy quartz, with crystals about 0.5 mm in diameter. Also in places, the outermost layer of chalcedony and drusy quartz is overlain by a surface coating of iron-stained, fibrous, length-slow chalcedony(?) about 0.5 mm thick. Recent studies have shown that much length-slow chalcedony contains moganite (also known in the literature as lucite), which is a monoclinic SiO₂ polymorph distinct from quartz (Heaney and Post, 1992); XRD confirmation for the presence of moganite in the Hidalgo County chalcedony has not yet been obtained. In some nodules, small patches of glassy, blebby opal (optically isotropic) with a very bright green fluorescence were the last material deposited.

The origins of agate, chalcedony, and geodes have been the subject of increased interest and study in recent years. A major controversy, not yet resolved, has been whether chalcedony forms by precipitation from dilute aqueous solutions that flow through cavities, or by crystallization of a dense, viscous silica gel that fills a cavity.
as a closed system. Building on the speculations and observations contained in such classic publications as those by Liesegang (1910) and Ross (1941), some very good treatises on the subject have appeared within the past dozen years; for example, Landmesser (1984), Macpherson (1989), and Pabian and Zarins (1994). In addition, an increasing number of papers have applied modern techniques of mineralogy and geochemistry to the study of agate and chalcedony; for example, Fallick and others (1985); Graetsch and others (1985); Wang and Merino (1990); Heaney (1993); and Lueth and Goodell (1995).

Symposium participants are invited to share their own ideas and insights about the origin of agate and chalcedony in the discussion following this presentation, so that together we may try to reach some increased level of understanding of what these nodules are telling us about the deposition of silica within cavities in rhyolite. I would like to particularly acknowledge the advice and unpublished information provided by Charles Bryan, Ramon S. DeMark, and Virgil E. Lueth in preparing this paper.

References:


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