

THE ORIGIN OF RHYOLITIC SPHERULITES AT ROCKHOUND STATE PARK

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One of the geologically-interesting features of the Rockhound State Park, in southern New Mexico, is the presence of numerous spherulites within the rhyolite lava. The spherulites range in size from less than 1 mm to greater than 30 cm, and many are solid, concentrically-zoned dark gray to pinkish colored material with a distinct, nodular, reddish core (Figure 1). Others consist of the same material, but are partly hollow. A third population may have started as a partly hollow spherulite, but the void has been filled by material which is recognizable as agate, chalcedony and quartz crystals. This type of filled spherulitic form is commonly called a “thunderegg”. In order to gain some insight into the process by which these spherulites form, samples were examined using

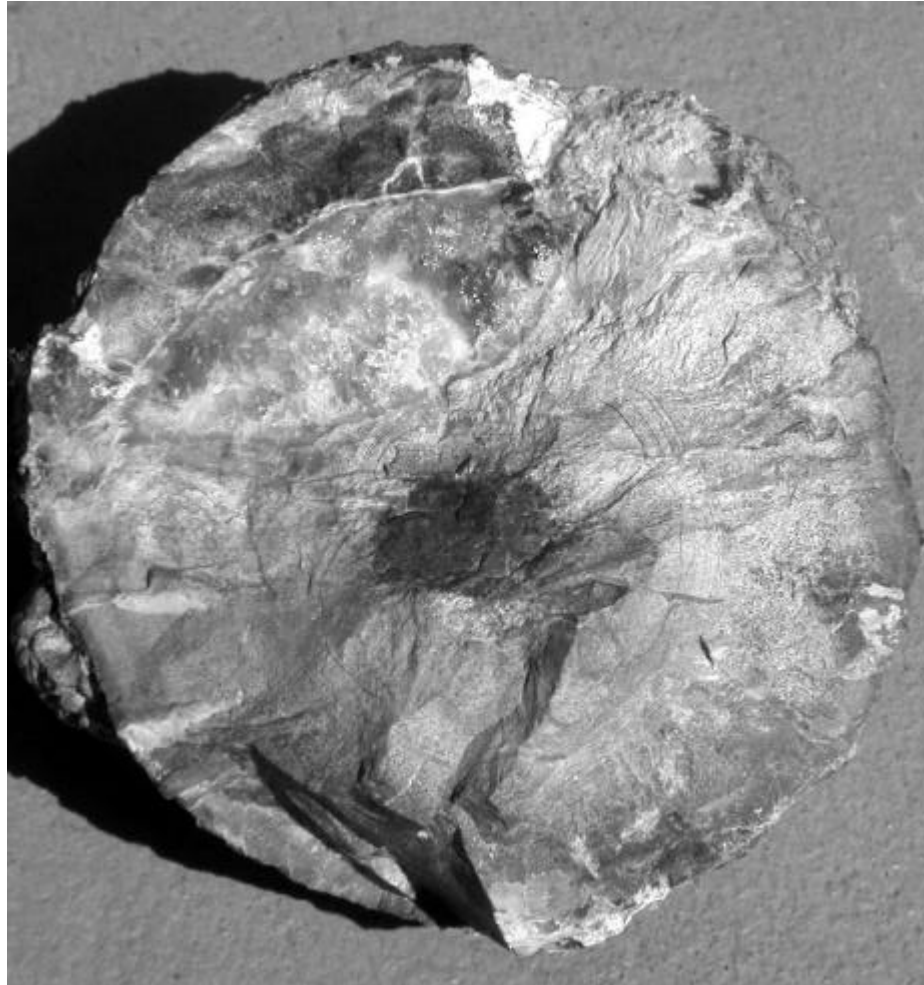


Figure 1. Rockhound State Park spherulite 14 cm in diameter. Dark red core is visible, as well as faint concentric layering. This spherulite contained a void space that has been filled by silica (upper left corner)

back-scattered electron imaging, x-ray imaging and qualitative and quantitative x-ray analysis using a Cameca SX-100 electron microprobe.

Microprobe examination of the concentrically-zoned portion of Rockhound spherulites show that they are composed of intergrown crystals of quartz (SiO_2), alkali feldspar ($\text{K,Na}[\text{AlSi}_3\text{O}_8]$), plagioclase feldspar $\text{Na}[\text{AlSi}_3\text{O}_8]$ - $\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]$ and magnetite (Fe_3O_4). The images from the microprobe show that the spherulites are formed either of intimately intergrown quartz, feldspar, and magnetite, or of bands of quartz systematically interspersed with bands of intergrown feldspar and quartz (Fig. 2). The bands range in width from around 100-200 microns, and it is this banding that produces the concentric structure that is apparent in some parts of the spherulites. The reddish, nodular cores of the spherulites are composed mainly of intergrown quartz and plagioclase, whereas the outer part of the spherulites contains quartz, plagioclase and alkali feldspar.

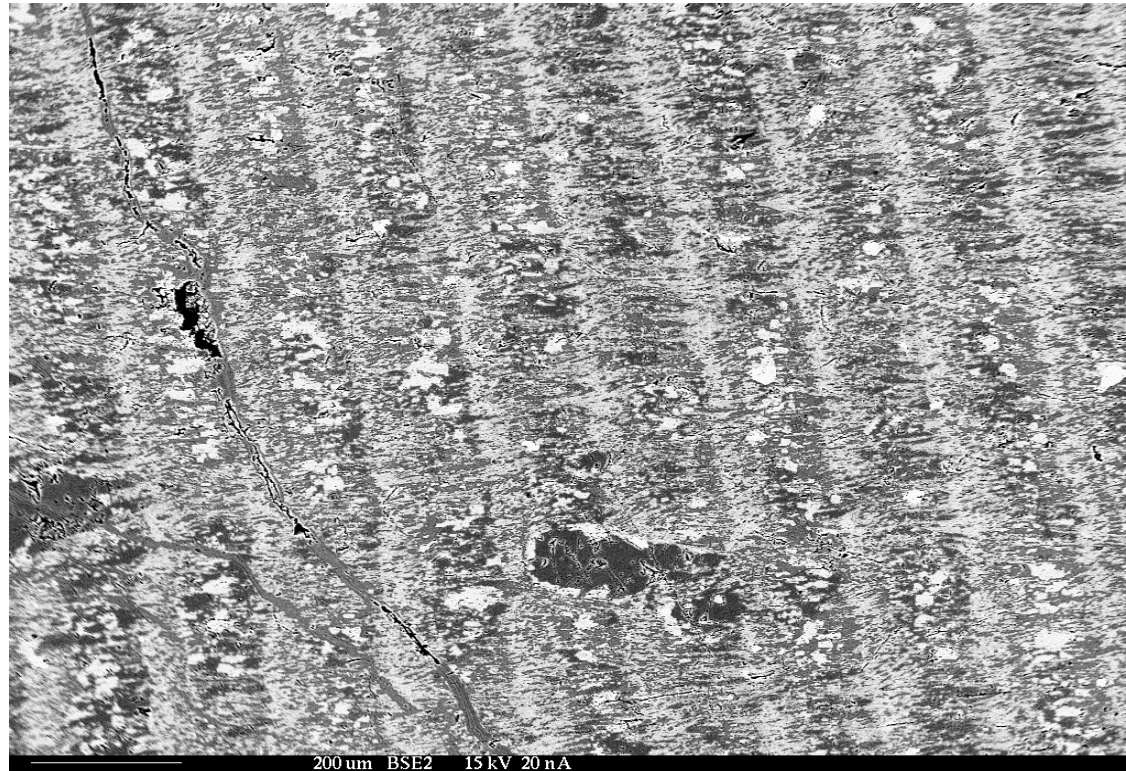


Figure 2. Backscattered electron image of the concentrically-zoned portion of a Rockhound State Park spherulite. The brightest areas in the image are magnetite, the medium grey areas are feldspars, the darkest grey are quartz, and the black area are void space.

The observed patterns in the spherulites suggest that they may have formed during the cooling of the rhyolite lava. Similar spherulitic forms, with similar internal growth features were observed in an artificial melt that was rapidly cooled (Jacobs et al., 1992; Dunbar et al., 1995). The temperature of the artificial melt was monitored during the cooling process, and exothermic crystallization was observed at high temperatures

(1100°C). Spherulitic growth occurred during this crystallization process, and the internal structure of the spherulites was indistinguishable from the internal structure of Rockhound spherulites. This similarity suggests that the Rockhound spherulites may have formed by a similar, high-temperature, rather than sub-solidus process. Furthermore, the feathery and non-equant crystal shapes observed in the Rockhound spherulites (Fig. 3) are very similar to crystal forms described by Lofgren (1970, 1971) for crystals that grew rapidly at high temperatures (~700°C), probably very soon after the rhyolitic lava was erupted onto the earth's surface.

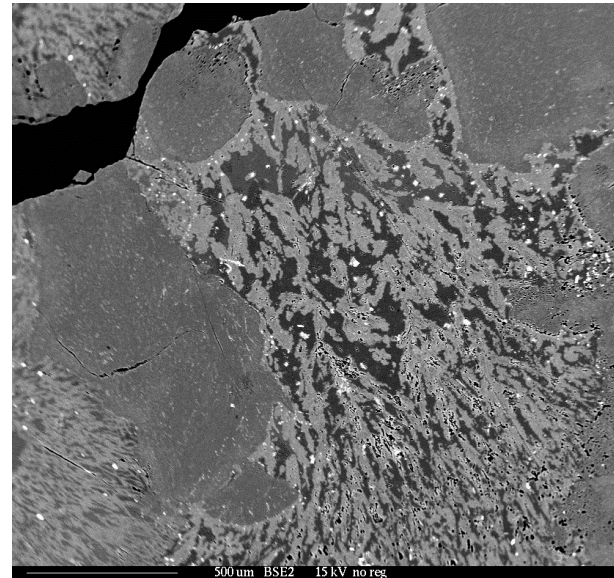


Figure 3. Feathery feldspar crystals in Rockhound State Park spherulite

Some Rockhound State Park spherulites developed internal void spaces, whereas others did not. Volume calculations of the amount of water vapor that could be generated during quartz and feldspar crystallization are within the same range as the volume of void spaces. This may suggest that the presence of void spaces may be related to vapor coalescence related to "second boiling" vapor generation during the growth of the spherulites. Backscattered electron image observations of some solid spherulites indicate the presence of numerous, small (~1-3 micron) void spaces interspersed with quartz and feldspar crystals, suggesting that vapor may have been generated in these cases, but was unable to coalesce to form a large void. Observations by other workers shows that the presence of void spaces in spherulites varies systematically within single outcrops (Colburn, 1999), suggesting that pressure or crystal growth rate may be controlling factors on generation or non-generation of large voids.

The presence of siliceous veinlets crosscutting the crystalline, outer portion of the spherulites indicates that the siliceous filling was emplaced after the outer part of the spherulite was brittle. The physical conditions of the filling process and under investigation.

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