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Structural Analyses of a Spherulite Mineral Using SEM, CL, and EDX

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Spherulites are polycrystalline textured bodies having a radial structure, and occur in polymers, inorganic salts, or rhyolites (volcanic rocks). Typical size of large spherulites in rhyolites is a few cm. However, SEM observation is necessary for detailed observation of smaller spherulites, because they are less than 100 µm. Large spherulite minerals are known to be made of fiber-formed crystals of Cristobalite (SiO_2) and the plagioclase ($NaAlSi_3O_8$), but it is unknown whether smaller spherulites also have the same structure. A rhyolite sample collected from Yamagata City in northeastern Japan was prepared for this study. The rhyolite sample is known to contain spherulites having two-layer structure by polarized light microscopy. Fine structure of the spherulites was analyzed by SEM, EDX, and CL (Cathodoluminescence). Experimental procedure was as follows: (1) making a thin section of the rhyolite for polarized light microscopy, (2) polishing the thin section to obtain flat surface for SEM observation by an ion milling system, then, (3) observing the texture of the spherulites with a polarizing microscope and making further investigations with several SEMs. One main mineral in the spherulites, plagioclase, was analyzed by EDX. The EDX mapping is suitable for visualizing the distribution of the plagioclase in the spherulite, because the plagioclase includes characteristic elements such as Na or Al. On the other hand, another major mineral in the spherulites, Cristobalite, cannot be identified by EDX, because its components are common elements of rocks such as Si. Thus, the distribution of the Cristobalite was analyzed by the CL system. An UVD (Ultra Variable-Pressure Detector) attached to an SEM was used for CL measurements.

Figure 1 shows BSE images of a spherulite; Figure 1a is whole image of a spherulite, and Figure 1b is a high magnification image of the outer layer. Crystals in the outer layer have fine structures like fiber form, while the crystalline texture in the inner layer is larger. BSE contrast between the Cristobalite and the plagioclase is low, because average atomic number of the plagioclase resembles that of the Cristobalite. Figure 2 shows CL images of the same spherulite; Figure 2a is whole image, and Figure 2b is a higher magnification image of the inner layer. Bright contrast minerals are Cristobalites. As the CL contrast of the outer stratum is also slightly brighter than that of the matrix, this result suggests that the outer stratum slightly includes Cristobalite. Fiber-like textured parts in the outer layer in Figure 1b are thought to be fine crystals of the Cristobalite. Figure 3 shows distribution of Na analyzed by EDX: Figure 3a is the whole image, and Figure 3b is a higher magnification image of the inner layer. This Na mapping shows distribution of the plagioclase in the spherulite. The inner layer has the plagioclase of polygon or fiber form crystals, and the outer layer includes plagioclase of the lower density than the inner layer. The low-density plagioclase in the outer layer may be related to part of the fine crystals in Figure 1b.

Conclusions of this study are as follows. Distributions of Cristobalite and plagioclase in a spherulite mineral have been visualized by SEM, CL, and EDX. The outer layer of the spherulite is comprised of plagioclase and Cristobalite texture having fiber-like fine structure. The inner layer also has plagioclase and Cristobalite texture, but the size of crystals is bigger than the outer layer.

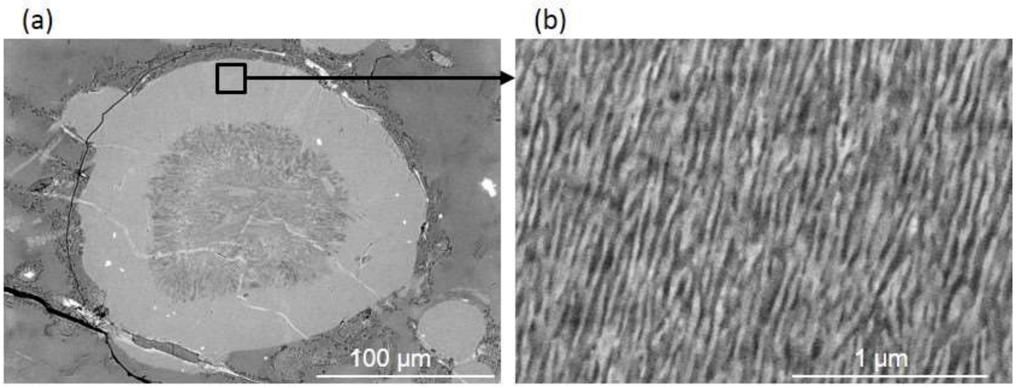

Figure 1. BSE images of the spherulite mineral having two-layer structure in the rhyolite: Whole image of the spherulite (a) and an enlargement image of the outer layer (b). Instrument: SU3500 (a), SU5000 (b). Acc. Volt: 5 kV, Magnification: x450 (a), x50k (b).

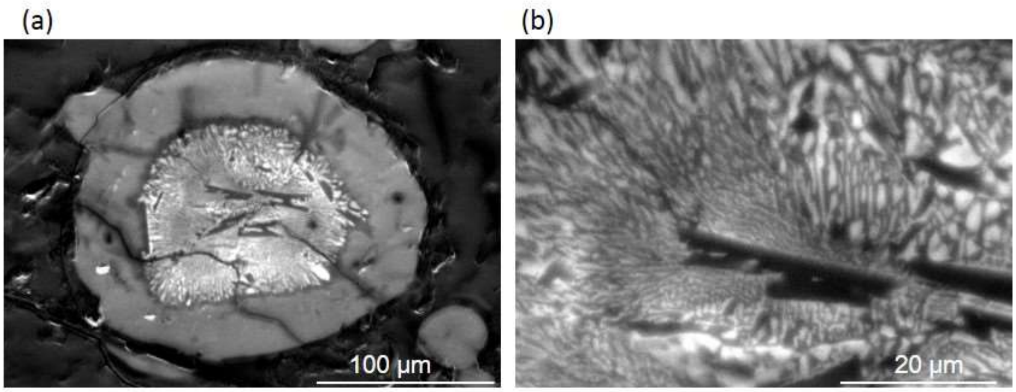

Figure 2. CL images of the spherulite mineral:
Whole image of the spherulite (a) and an enlargement image of the inner layer (b).
Instrument: SU3500. Acc. Volt: 15 kV, Magnification: x450 (a), x2k (b).

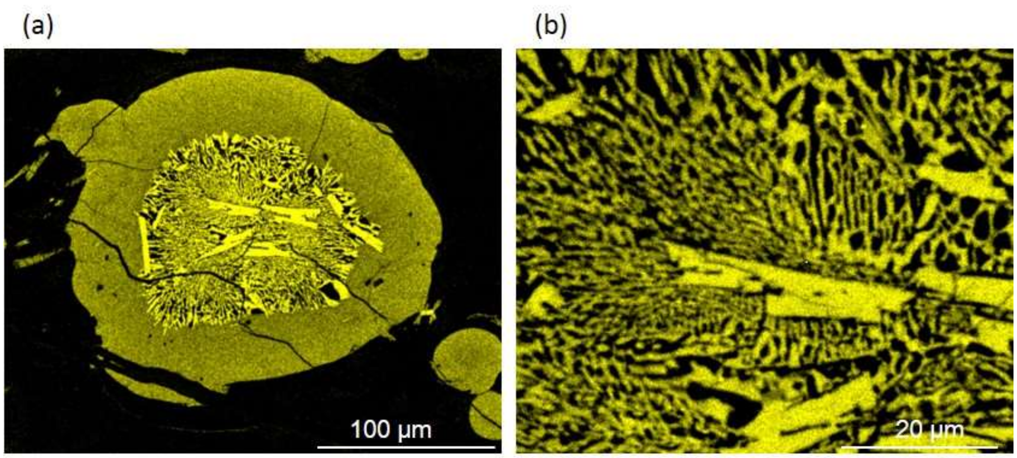

Figure 3. EDX mapping images of the spherulite mineral:
Whole image of the spherulite (a) and an enlargement image of the inner layer (b).
Instrument: SU3500. Acc. Volt: 8 kV, Magnification: x450 (a), x2k (b).