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Growth of megaspherulites in a rhyolitic vitrophyre

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Abstract

Megaspherulites occur in a rhyolitic vitrophyre, near the base of a thick rhyolitic vitrophyre that occupies a late Eocene to early Oligocene volcanic-tectonic basin near Silver Cliff, Colorado. Diameters of the megaspherulites range from 0.3 to over 3.66 m, including an alteration layer. The megaspherulites are compound spherulites. They are holocrystalline, very fine- to fine-grained, composed of sanidine and quartz, and surrounded by a thin sanidine-quartz rind, and an alteration layer containing mordenite and 15 Å montmorillonite.

Megaspherulite crystallization began soon after the vitrophyre was emplaced as the result of sparse heterogeneous nucleation, under highly nonequilibrium conditions. Spherulite growth proceeded in a diffusion-controlled manner under lowered viscosity as a result of a high water content (5 to 7 wt%), which also contributed to sparse nucleation. When nucleation did occur, it was at a large ΔT (245–350 °C) on near critical-sized nuclei. Once the spherulites began to grow, continued nucleation was on existing growth cones and new, independent spherulites did not form. Sanidine crystals grew with a fibrous habit, which is favored by a large ΔT, restricting fibril lengths and diameters between 10–30 and 3–7 μm, respectively. During crystallization, these growth cones impinged upon each other, resulting in fibril cone-free areas. These cone-free (interconal) areas consist of coarser, fine-grained phases, dominated by quartz, which crystallized from the melt as it accumulated between the crystallizing sanidine fibrils of the cones. The anhydrous nature of the sanidine and quartz suggests that their crystallization concentrated a water-rich residual fluid, enriched in Ca, Mg, and Fe, and depleted in Si, K, and Na, at the megaspherulite-vitrophyre interface. This fluid phase enclosed the megaspherulites resulting in the hydrothermal alteration of the vitrophyre, forming a hydrothermal alteration layer, as indicated by the presence of the minerals mordenite and montmorillonite.