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Epidote spherulites and radial euhedral epidote aggregates in a greenschist facies metavolcanic breccia hosting an UHP eclogite in Dabieshan (China): Implication for dynamic metamorphism

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ABSTRACT

Epidote spherulites are identified in a greenschist facies metavolcanic breccia enclosing a body of coesite-bearing eclogite at Ganghe in the Dabie ultrahigh-pressure metamorphic belt, east-central China. The epidote spherulites are formed by fibrous, radially arranged, and rare earth element (REE)-rich epidote crystals (ΣREE = 0.13–0.36 (or slightly higher) cations per formula unit, cpfu) and interfibrillar REE-poor epidote (ΣREE ≤ 0.10 cpfu). Some of the epidote spherulites are overgrown by radially arranged euhedral epidote crystals, which also form aggregates around preexisting quartz, plagioclase, and/or epidote. The epidote grains in such aggregates display oscillatory zoning, with REE content varying from a negligible amount to about 0.44 cpfu. Epidote also occurs as REE-poor individual euhedral crystals about the radial epidote aggregates or form loose clusters of randomly oriented crystals. Thermodynamic modeling of the mineral assemblages in the plagioclase pseudomorphs and in the matrix shows that they formed at greenschist facies metamorphic conditions (435–515 °C and 5–7 kbar). The epidote spherulites and radial euhedral epidote aggregates, however, do not belong to these assemblages and are non-equilibrium textures. They imply crystal growth under large degrees of supersaturation, with relatively low ratios of the diffusion rate (D) to the crystal growth rate (G). At low D/G ratios, spiky interfaces are favorable for diffusion-controlled growth and the resultant texture is a collection of spikes around a growth center, forming a spherulite. The change of epidote texture from spherulite to radial euhedral crystal aggregate implies a decrease of supersaturation and an increase of D/G, such that the crystal morphology was controlled by its crystallographic structure. The crystallization of the individual epidote grains corresponds to a further drop of supersaturation and a further increase of the D/G ratio, approaching to the equilibrium conditions. Transiently higher P-T conditions are inferred from the spherulite-forming reactions, relative to the P-T estimates for the equilibrium assemblages. The fibrous crystals in the spherulites having relatively large interfacial energies would inevitably adjust their shapes to equilibrium ones with low interfacial energies if the P-T-H_2O conditions were maintained for a sufficiently long period of time. The non-equilibrium epidote aggregates likely formed in response to P-T and fluid pulses, possibly related to seismicity.

Keywords: Dabieshan, epidote, non-equilibrium, radial euhedral crystal aggregates, spherulite, supersaturation