Texture of the pseudotahylyte-like veins in a carbonated serpentinite: implications to the genesis

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Pseudotachylyte-like veins occur in a carbonated serpentinite from the Nishisonogi unit, the Nagasaki Metamorphic Rocks (Cretaceous palaeo-subduction complex), western Kyushu, Japan. The veins show several varieties in their appearance from homogeneous and glassy to partially cataclastic one, suggesting totally to partially molten (and solidified) fault gouges. The occurrence of microdiamonds indicates an ultrahigh-pressure condition for their genesis (Nishiyama et al., 2021). Another supporting evidence for the ultrahigh-pressure condition is the occurrence of magnesite + calcite (former aragonite) as a high-pressure dissociation product of dolomite.

This paper will describe the internal texture of the veins, and discuss the genesis of the veins based on the observation of the internal texture.

Internal texture of the pseudotachylyte-like veins

The pseudotachylyte-like veins contain no glass, but consist of recrystallized very fine-grained quartz (several micrometers in size) and carbonates (several tens of micrometers). Several conspicuous features characterize the internal texture of the pseudotachylyte-like veins: (1) spherulite-like texture, (2) dog-tooth carbonates with oscillatory zoning, and (3) growth texture of idiomorphic quartz.

(1) spherulite-like texture

Spherulite-like aggregates occur in some pseudotachylyte-like veins, consisting of magnesite and quartz with or without dolomite. The size of the aggregates ranges from several hundreds of micrometers to 1 millimeter. The aggregates have a core consisting mostly of magnesite and quartz mantled by aggregates of fine-grained quartz. In some cores, calcite occurs in contact with magnesite without dolomite between them.

(2) dog-tooth carbonates with oscillatory zoning

In some pseudotachylyte-like veins, a composite vein structure is observed such that a magnesite + quartz layer is sandwiched by magnesite layers along the vein walls. The magnesite layers consist of dog-tooth magnesite crystals with distinct oscillatory zoning in terms of Fe –Mg substitution. The dog-tooth magnesite grows from the vein wall towards the vein center, invading into the magnesite + quartz layer.

(3) growth of idiomorphic quartz

At both boundaries of the magnesite layer in the composite vein, growth of idiomorphic quartz is observed. At the boundary with the country rock, quartz is recrystallized to form idiomorphic grain invading into the magnesite layer. The same phenomenon is observed at the boundary with the magnesite + quartz layer. Thus, idiomorphic quartz grains invade into the magnesite layer from both sides. Idiomorphic quartz also occurs rarely in the magnesite + quartz layer in the composite vein. In a pseudotachylyte-like vein in a dolomite + quartz rock, no composite structure is observed. The vein consists of a single dolomite + quartz layer, and idiomorphic quartz grows into anhedral dolomite which shows oscillatory zoning.

Genesis of the pseudotachylyte-like veins

Varieties in the internal texture of the pseudotachylyte-like veins requires a careful discussion on the origin of the pseudotachylyte-like veins. Spherulite-like texture indicates rapid crystallization of magnesite and quartz in a melt of $MgCO_3$ + SiO_2. In some spherulite-like aggregates, original paragenesis of magnesite + calcite (former aragonite) was replaced by dolomite during pressure descent. The origin of

dog-tooth magnesite will be controversial. It can be a crystallization product from the melt during cooling of the pseudotachylyte-like veins, or it may represent a recrystallization of magnesite owing to fluid infiltration later than the solidification of the pseudotachylyte-like veins. The texture of dog-tooth magnesite invading into the central magnesite + quartz layer supports the former idea, because the central layer should be a melt during the growth of the dog-tooth magnesite. However, it means a slow cooling of the pseudotachylyte-like veins, which is contrary to the rapid cooling texture such as spherulite-like aggregates in a very fine-grained quartz matrix. A probable interpretation for the formation of the composite vein is the following. An earthquake-generating faulting in a carbonated serpentinite formed a molten zone along the fault. The molten zone cooled down slowly with crystallization of magnesite form the wall at the earlier stage of the cooling, then it cooled down rapidly to form a very-fine grained quartz matrix with or without spherulite-like aggregates. The release of latent heat by crystallization of dog-tooth magnesite may be a cause for the slow cooling of the molten zone at the earlier stage of the cooling.

Keywords: pseudotachylyte, carbonated serpentinite, spherulite, dog-tooth magnesite, oscillatory zoning, Nagasaki Metamorphic Rocks

