

Ultrahigh-pressure pseudotachylyte in a marble

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A black vein in a marble from the Higo metamorphic rock in central Kyushu, Japan, represents a signature of dolomite growth from a carbonate melt and also evidence of liquid immiscibility between carbonate and silicate melts. The formation condition is estimated to be 3.5 GPa and 1280 C by the dolomite composition based on the phase diagram in the system CaCO_3 – MgCO_3 . This is a peculiar example of pseudotachylyte formed under ultrahigh-pressure condition.

The Higo metamorphic rock is Cretaceous low P/T metamorphic rock, however, some authors have suggested the existence of high to ultrahigh-pressure metamorphism prior to the low P/T metamorphism. In the south of Mt. Kousadake, Tomochi Town, Kumamoto Prefecture, marble occurs as several layers intercalated with pelitic and siliceous gneisses. The thickness of the marble layer is variable from several meters to several tens of meters. In one of the marble layers, near the contact with the surrounding pelitic gneiss, we found a black vein 10 cm thick and 1 m long, of which strike crosscuts that of the boundary between the marble and gneiss. It shows a branching texture, extending perpendicular to the vein strike from the vein towards the country rock (marble). The branching is a signature typical to the pseudotachylyte.

The marble consists of pure calcite, whereas the black vein consists of dolomite domain and silicate domain. The dolomite domain is composed of aggregates of anhedral to subhedral dolomite grains of 10 micrometers in size with oscillatory or complex zoning in terms of Ca, Mg and Fe. The dolomite grains do not show any deformation texture. The dolomite domain occasionally includes fractured quartz clasts, of which fractures are filled with dolomite. The silicate domain occurs as rounded or irregular-shaped aggregates of several hundred micrometres in size. It consists of rounded quartz grains, fibrous aggregates of hydrous alumino-silicate (unknown clay mineral) and minor dolomite grains. The silicate domains occur sporadically in the dolomite domains, and some silicate domains are connected with each other by network veins of silicates of the same material as the silicate domain. Rounded zircon rarely occurs in the silicate domain. In some parts of the vein, thin marble layers several millimeters thick occur, showing a flow folding.

Subhedral shape, oscillatory zoning and non-deformed texture of dolomite in the dolomite domain indicates the origin of dolomite either as precipitates from the fluid or as growth in the melt. If dolomite precipitated from the C-O-H fluid, the assemblage of dolomite + quartz, which occurs both in the dolomite and silicate domains, is stable at relatively low T, high P and high XCO_2 region. Outside the stability field, it will react to form diopside. Diopside is common in calc-silicate gneisses in this region, therefore, the assemblage of dolomite + quartz + C-O-H fluid would imply temperature condition lower than that of the regional metamorphic condition. This observation leads to a conclusion that the dolomite grew from the melt, because fault rocks should show temperature condition higher than that of the country rock owing to frictional heating. The silicate domain may represent recrystallized silicate melt, and the coexistence of carbonate and silicate domains implies the liquid immiscibility between carbonate and silicate melts. In such a case, dolomite should represent a minimum melt composition in the system CaCO_3 – MgCO_3 . The minimum melt composition and its temperature depends strongly on pressure (Irvine and Wyllie, 1975 and Buob et al., 2006), therefore, we can estimate the melting temperature and pressure from the dolomite composition. The effect of FeCO_3 component is evaluated to be small based

on the experiment of Shatsky et al. (2014). The estimated pressure and temperature conditions are 3.5 GPa and 1280 C. Thus, we interpret that the black vein is a pseudotachylyte formed under ultrahigh-pressure condition, indicating that the Higo metamorphic rock has experienced the ultrahigh-pressure.

References: Buob, A., et al. (2006) *Amer. Mineral.*, 91, 435-440; Irvine, A.J. and Wyllie, P.J. (1975) *GCA*, 39, 35-53; Shatsky, A. et al. (2014) *Amer. Mineral.*, 99, 773-785.

Keywords: Ultrahigh-pressure metamorphism, pseudotachylyte, Higo metamorphic rock