# Microstructure of the reaction zones associated with marbles of Ryoke metamorphic complex in the Yanai area, Yamaguchi prefecture.

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The Ryoke metamorphic complex in the Yanai area, SW Japan, consists of granite and high-temperature metamorphic rocks derived from the Jurassic accretionary complex. The metamorphic rocks are composed mainly of pelitic and siliceous lithologies with small amount of calcareous and mafic ones. The study area has been divided into seven metamorphic zones based on pelitic mineral assemblage.
We investigate the calcareous layer embedded in pelitic gneisses in the highest-grade garnet-cordierite zone, of which conditions are estimated as 850 ℃ and 600 MPa.
Two types of reaction zone are recognized within marble(A) and at the boundary between marble and quartzite(B).
Sphene(Spn) occurs only at the central part of both reaction zones, which divides these zones into Inner part and Outer part.
The Inner part of A consists of plagioclase (Pl) and clinopyroxene (Cpx) with minor clinozoisite (Czo) and K-feldspar (Kfs). It contains phlogopite (Phl) locally. The minor Czo replaces the rims of Pl along the grain boundary. The Outer part of A is composed of Czo and Cpx. In contrast, B consists of Inner part including Cpx, Kfs and minor Pl and Czo and Outer part of wollastonite (Wo). The amount of Wo is larger on the quartzite side than on the marble side.
The bulk compositions of marble and quartzite can be approximated to $CaCO_3$ and $SiO_2$, respectively. This two-component system cannot account for the formation of the minerals in the reaction zones except Wo. Spn is the only mineral containing Ti that is an immobile element. It is reliable that the Inner part represents some Spn-bearing layers before the formation of the reaction zones. Czo replaces the rims of Pl along the grain boundary in the Inner part of zone A. Czo and Pl occur also in the Inner part of zone B, as well as Phl in that of zone A. Therefore, the Spn-bearing layer was likely composed at least of Spn, Pl and locally Phl. The minerals in the Outer part, Czo, Cpx, Kfs and Wo, were produced by the metasomatic reactions among marble, quartzite and Spn-bearing layers.
The microstructure of Czo that replaces Pl is indicative of the reaction,
Plagioclase + Calcite + $H_2O$ = Clinozoisite + $CO_2$ (1)
($3CaAl_2Si_2O_8 + CaCO_3 + H_2O = 2CaAl_3Si_3O_{12}(OH) + CO_2$).
The occurrence of Cpx and Kfs in the Outer part implies that Phl was consumed to produce these minerals, of which reaction may be expressed as
Phlogopite+ Calcite + Quartz = Diopside + K-feldspar + $CO_2$ + $H_2O$ (2)
($3KMg_3(Si_3Al)O_{10}(OH)_2 + 3CaCO_3 + 6SiO_2 = 3CaMgSi_2O_6 + KAlSi_3O_8 + 3CO_2 + H_2O$).
The formation of Wo in the Outer part of zone B is explained by the reaction,
Quartz + Calcite = Wollastonite + $CO_2$ (3)
($SiO_2 + CaCO_3 = CaSiO_3 + CO_2$).
The minerals on the left-side of the reactions are interpreted as products based on the microstructures. They are stable under lower $XCO_2$ conditions than the right-hand sides and under higher temperatures except reaction (1). Changing temperature cannot be responsible for all the reactions to proceed. Decreasing $XCO_2$ of coexisting fluid would be plausible. The temporal order of the three reactions depends on the pressure-temperature condition, which will be determined based on the careful

 

microstructural investigation.

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