Summary

Thesis title Petrological studies of granulite facies metamorphic rocks from the middle segment of Mogok metamorphic belt, central Myanmar

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The Mesozoic to Cenozoic tectonic evolution of Southeast Asia is characterized by the closure of the Tethys ocean and subsequent collision of the Indian microcontinent with Eurasia. Progressive convergence between these two continental plates resulted in the development of Cenozoic high-temperature metamorphism and related magmatism in central Myanmar. The Cenozoic Mogok metamorphic belt, located at the western margin of the Shan-Thai Block forms a prominent part for understanding the continental evolution of Southeast Asia. Systematic investigations of tectonometamorphic conditions of the Mogok metamorphic belt and related magmatism are therefore essential to the discussion of tectonic evolution of this region. Geochronological studies, based on U–Th–Pb and Ar–Ar dating, indicates that an assemblage of the Mogok high-grade metamorphic rocks formed during the Paleogene to early Neogene in association with the India–Eurasia continental collision (Bertrand et al., 1999; 2001; Searle et al., 2007; Maw Maw Win et al., 2016).

Ti-rich biotite grains commonly occur in paragneisses of the Mogok metamorphic belt, Myanmar. The TiO_2 content of biotite coexisting with rutile and/or ilmenite reaches 6.9 wt%. The compositional relationships between Ti content and other components such as total cation, total divalent cation, Si, and Al, suggest that the Ti-vacancy exchange vector of $Ti\square R_{-2}$, where R is the sum of divalent cations and □

represents vacancy in the octahedral sites, might be the most effective mechanism to control Ti-substitution into biotite that coexists with no Al_2SiO_5 phase under high-temperature conditions. On the other hand, Ti-tschermak's exchange vector of $TiAl_2R^{2+}_{-1}Si_{-2}$ is probably a common mechanism by which the TiO_2 content of biotite is increased in Al_2SiO_5 phase-bearing samples with increasing temperature.

Cordierite-bearing paragneiss and associated garnet-biotite paragneisses are also studied for the understanding of the tectonometamorphic evolution. The garnet– biotite–plagioclase– sillimanite– quartz and garnet–cordierite–sillimanite–biotite–quartz assemblages and their partial systems suggest pressure–temperature (*P–T*) conditions of 0.60–0.79 GPa/800–860°C and 0.65 GPa/830°C, respectively, for the peak metamorphic stage. The *P-T* pseudosection analyses of the inclusion phases in garnet and matrix assemblage suggest prograde path from 700–730 °C to 710–765 °C at 0.68–0.78 GPa. The Ti-in-biotite geothermometer and the Zr-in-rutile geothermometer yield temperature conditions up to 820°C and of 845 ± 26°C, respectively. Anhedral cordierite with slightly higher X_{Mg} values and associated assemblage around garnet shows re-equilibration under lower *P–T* conditions of about 0.4 GPa/620°C. Based on the CHIME monazite age in the paragneiss, the lower-teperature equiibrium was interpreted to be related to fluid activity during exhumation in the late Oligocene (Maw Maw Win et al., 2016). The comparisons of present data and *P–T* conditions reported in literature suggest that (1) the metamorphic conditions of the Mogok metamorphic belt vary from the lower amphibolite- to granulite facies, (2) metamorphic grade seems to increase from east to west perpendicular to the north-trending extensional direction of the Mogok belt, (3) granulite facies rocks are widespread in the middle segment of the

Mogok belt, and (4) the granulite facies rocks were locally re-equilibrated at lower amphibolite facies conditions during the exhumation.

Dolomitic marbles and scapolite-bearing calc-silicate rocks also dominate in the middle segment of the Mogok metamorphic belt. The high-grade assemblages of the marble samples are mainly composed of calcite + dolomite + phlogopite + spinel, and those of calc-silicate samples are represented by scapolite + calcic plagioclase + quartz + diopside + calcite + titanite. Some marble samples contain clinohumite, forsterite, diopside, and amphibole. Calcite grains in the marble samples usually show exsolution texture including small grains of dolomite. The estimated compositions of homogeneous calcite grains before the formation of exsolution texture yield 720 – 870 °C as minimum temperature conditions using calcite-dolomite solvus geothermometer. The stability relationships of mineral parageneses in the clinohumite-bearing marble and scapolite-bearing calc-silicate rocks were analyzed in the systems of $CaO\text{-}MgO\text{-}SiO_2\text{-}H_2O\text{-}CO_2$ and $CaO\text{-}MgO\text{-}Al_2O_3\text{-}TiO_2\text{-}SiO_2\text{-}H_2O\text{-}CO_2$ at pressure condition of 0.8 GPa, respectively. In the clinohumite-bearing sample, forsterite and calcite occur as inclusions in clinohumite porphyroblast suggesting high-temperature and X_{CO2} conditions of > 800 °C and > 0.54, respectively. Dolomite and symplectitic aggregates of tremolite and dolomite occur at the boundary between clinohumite and calcite. This re-equilibrium texture indicates decrease of X_{CO2} condition during retrograde stage. The assemblage of meionitic scapolite, calcite and quartz in calc-silicate samples yields minimum temperature and X_{CO2} conditions of 770–790 °C and 0.2, respectively, suggesting peak metamorphic stage. Aggregates of zoisite/clinozoisite, calcite, and quartz replace scapolite indicating decrease of X_{CO2} value during retrograde stage.

The high-temperature conditions over 800 °C at peak metamorphic stage recorded in marble and calc-silicate rocks are well consistent with those estimated by paragneiss assemblages. The X_{CO2} value of metamorphic fluid attended during the peak metamorphic stage, however, had distinctly higher in the metacarbonate rocks than the paragneisses that were free of carbonate phases. This fact suggests that migration of metamorphic fluid phases were limited between the two types of lithologies, and thus, homogenization of metamorphic fluid compositions has not extensively occurred during prograde metamorphic stage. On the other hand, decreasing X_{CO2} values of metacarbonate rocks with decreasing temperature might indicate that infiltration of H_2O-rich fluid extensively occurred beyond the lithologic boundaries during retrograde metamorphic stage.