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Feldspar in felsic rock: implications for UHT processes

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Felsic orthogneisses are common constituent in granulite-gneiss terrane. These rocks have relatively simple mineral assemblage, such as quartz + feldspars + biotite and/or amphibole, or pyroxenes in place of biotite and amphibole at higher-T or lower-a(H2O) conditions. These mineral parageneses are stable over wide P-T range, and, therefore, have been thought as not so useful for estimating the metamorphic conditions and processes. Geochemical characteristics of these felsic orthogneisses can be used for evaluating the original magmas. It is, however, not always easy to assess the effect of the compositional modification, even if minor, during the metamorphism. This study aims to discuss the UHT metamorphic processes including the chemical behavior controlled by fluid and/or partial melting based on the chemical composition and mineral texture of feldspars in felsic gneiss from the Napier Complex, Antarctica. UHT metamorphic conditions of the Napier Complex have been examined using diagnostic minerals such as sapphirine, osumilite and garnet in relatively minor lithologies. It is more important to understand the behavior of felsic gneisses, as these rocks form large proportion of the complex, and, therefore, can be significant heat and water budget during UHT processes. Six felsic orthogneiss samples used in this study were collected from Mt. Riiser-Larsen area where is the largest outcrop in the Napier Complex. Geochemical features suggest that these felsic gneisses are typical of Archaean TTG (tonalite-trondjemite-granodiorite). Three of the analyzed samples are classified as 'tonalitic (SS97011505, SS97011304, SS97021102: Opx + Qtz + antiperthite + minor Cpx)' and other three are 'granodioritic˜granitic (SS97012401, SS97020402A, SS97012101: Opx + Qtz + mesoperthite)'. Opx, quartz and feldspars are granoblastic, and rarely show elongation or arrange in parallel to form gneissosity. Zircon, ilmenite, magnetite with/without apatite are minor in both types of gneisses. Pre-exsolution one phase compositions of these antiperthitic and mesoperthitic feldspars have been estimated using the method described in Hokada (2001). Exsolutuion lamellae are commonly restricted in core-mantle of the feldspar grains, and lamella-free area is commonly developed in the rim. So, the pre-exsolution one-phase compositions have been recovered as (a) composition of feldspar whole-grain and as (b) composition of feldspar core where exsolution lamellae concentrated. As the results, three 'tonalitic' samples give core (an:ab:or=20-28:53-56:17-28) and whole grain (an:ab:or=24-29:58-63:13) compositions, and three 'granodioritic' samples show core (an:ab:or=15-17:37-48:36-48) and whole grain (an:ab:or=18-20:45-56:24-37) compositions. All these suggest that lamellae-condensed cores have 4˜15 mol% higher orthoclase component than the whole feldspar grain. According to feldspar solvus model proposed by Fuhrman & Lindsley (1988), the estimated one-phase feldspar core compositions were stable over 950-1100 C, and whole grain compositions were stable at over 900-1050 C. The compositional differences between core and whole grain are considered to be derived from one (or some) of following possibilities: (1) Feldspar grain was once homogeneous, and the orthoclase component in the core has been precipitated as exsolution lamellae whereas the orthoclase component in the rim has been extracted to the outside of the grain during cooling. (2) The feldspar core-rim variation is compositional zoning, and the lamella-free (orthoclase-poor) rim post-dates the core as the temperature decreases. (3) Later modification by fluid infiltration caused the partial removal of K2O component in the feldspar rim. (4) Feldspar grains may have been precipitated from partial melt generated during the UHT metamorphism, and the compositional change of feldspar crystals is controlled by the change of the coexisting melt compositions.