Petrological study of orthogneiss hosting ultrahigh pressure metamorphic rocks from Tromsø Nappe in Caledonides

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The spatial extent/distribution of ultra-high pressure (UHP) metamorphic rocks gives a critical boundary condition to consider the exhumation process of the relevant area. Main lithotype hosting UHP metamorphic rocks in the world is orthogneiss in general, and most of orthogneiss mainly consist of amphibolite facies minerals that harm to determine the exact spatial extent/distribution of the UHP terranes. However, evidences of UHP metamorphism such as coesite and jadeite have been found from orthogneiss in Dabie-Sulu terrane in early 90's (Tabata et al., 1998). Therefore, the orthogneiss hosting coesite-bearing eclogites is considered to be suffered UHP metamorphism along with the hosting UHP rocks, in spite of the missing of UHP evidence. Scandinavian Caledonides, which formed by continental collision between Laurentia and Baltica during Ordovician to Devonian, are the cradle of the eclogite study since Eskola, and they are composed of a pile of several nappes. The Western Gneiss Region in the Lower Allochthon is one of the first identified UHP terranes (Smith, 1984), where the UHP rocks are exposed 60 x 150 km^2 and showing northwestward increase of pressure and temperature, therefore, this area can be regarded as one of type locality of the continental subduction. In recent years, the Middle (the Seve Nappe; Majka et al., 2014) and the Uppermost (the Tromsø Nappe) Allochthon became new members of UHP terranes. In the Tromsø Nappe, Janák et al. (2012) calculated UHP metamorphic conditions (720 - 800 C and 3.2 - 3.5 GPa) based on the pseudosection modeling and conventional geothermobarometry. Furthermore, Janák et al. (2013) found microdiamonds as inclusions in garnet in carbonaceous gneiss. However, evidences of UHP metamorphism are found from only limited rocks and not found from country gneisses and schists. In this study, we report petrology and zircon U-Pb chronology of orthogneiss hosting UHP rocks in the Tromsø Nappe. Main constituent minerals are garnet, muscovite, plagioclase and quartz with subordinate amounts of alkali-feldspar, biotite, tschermakite, rutile, zircon and apatite. Some of plagioclases show augen structure (ca. several cm in long dimension) and characterize the gneissose structure. Most garnets have euhedral shape (tens of μm to 1 mm) and show following zoning patterns: (1) Ca-poor (X_{Grs} = 0.09 - 0.16) and Y-rich core with a lot of inclusions, (2) Ca- (X_{Grs} = 0.09 - 0.16) and Y-poor rim with few inclusions, (3) Ca-rich (X_{Grs} = 0.20 - 0.26) and Y-poor outer rim with few inclusions. Identified inclusion phases in the core are quartz, muscovite, rutile zircon and minor kyanite. There are a slight but significant chemical gaps between core-rim and rim-outer rim boundaries in X-ray mappings of Ca and Y, and the shape of them is roundish. These data suggest that garnet once dissolved after the formation of the core and then recrystallized. Garnets with the above mentioned structure occur not only in the matrix but also as inclusions in muscovite, plagioclase, tschermakite and zircon. Most plagioclases have Ca-rich core (X_{An} = 0.26 - 0.33) and Ca-poor rim (X_{An} = 0.17 - 0.25). The rim of plagioclase is inferred to supply Ca to the garnet rim. The conventional geothermobarometries give 667 ± 43 C and 1.5 - 1.7 GPa for the pair of the garnet core and the plagioclase core, and 700 - 750 C and 1.6 - 1.8 GPa for the pair of the garnet outer rim and plagioclase rim. These estimated data are equivalent to amphibolite facies. The LA-ICP-MS U-Pb dating of zircon in orthogneiss gives the concordant age between 480 and 420 Ma, and inherited ages between 2500 and 900 Ma. The weighted mean $^{206}Pb/^{238}U$ age of zircon rim is 453.2 ± 3.2 Ma (n = 61). The last age overlaps with literature data within error, i.e., metamorphic age of eclogites (452.1 ± 1.7 Ma of zircon ID-TIMS age; Corfu et al., 2003). More than 300 grains of inclusions in zircon are tested using Raman spectroscope and EPMA, and they are quartz, muscovite, apatite and minor amount of garnet and biotite. Most inclusions occur in inherited core showing oscillatory zoning. As the present state conclusion, no evidence of UHP metamorphism has been found from Tromsø Nappe orthogneiss.