The formation of micro- to nano-pores in feldspars induced by fluid infiltration within the crust

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Micro- to nano-pores are commonly formed during feldspar replacement and potentially act as fluid pathways within the crusts. However, there is a large variety of textures and conditions of pores, thus the effects of host minerals and fluid compositions on pore generation are poorly understood. This study reports novel occurrences of pores within altered plagioclase grains in the mafic schists around the pegmatite-bearing quartz diorite body in the Kinkazan Island, NE Japan. We reveal the temporal relationship of metamorphism, fluid infiltration, and pore generation. In addition, we conducted hydrothermal experiments on plagioclase replacement to examine the effects of fluids and host minerals.

Analyses of three mafic schists in the Kinkazan Island reveal the multiple stages of fluid infiltrations during cooling after the intrusion of quartz diorite. The quartz diorite is mainly composed of hornblende and plagioclase and the P-T conditions were estimated to be 710-760˚C and 0.3 –0.45 GPa. The first stage of fluid infiltration into the surrounding mafic schists was characterized by pegmatitic veins with reaction zone in which replacement of clinopyroxene by hornblende and Ca-rich plagioclase I (An80-90) by plagioclase II (An40-60). Assuming the similar pressure to quartz diorite, the temperature was estimated to be ~545˚C and the sodium-rich fluid infiltration was inferred. The second stage is the infiltration of potassium-rich fluid at 430-490˚C. In this stage, plagioclase III (An4Ab94Or2) and K-feldspar (An0Ab1Or99) were formed as the replacement products of plagioclase II. This stage of alteration is characterized by ubiquitous occurrences of the micro- to nano-scale pores. The mass balance analyses indicate the feldspar replacement is characterized by the gain of SiO_2 and K_2O and the losses of Al_2O_3 and CaO, with almost constant Na_2O. Furthermore, the later potassium-rich fluid propagated subsequently to form a K-feldspar vein which coexists with the lower-Al hornblende and the other micro-scale pores, then actinolite composition replaced the hornblende at the following stage. The profound diversity of replacement presents the change of fluid composition from the sodium-rich to the potassium-rich fluid as a decreasing temperature. Those fluids may emerge different pores properties according to certain host mineral compositions.
In order to understand the feldspar replacement and pore generation, we have started hydrothermal experiments of feldspar replacement. As the preliminary results, we found the development of micro-size pores at the reaction front of albite replacement by K-feldspar in an aqueous 2 M KCl under 600˚C & 150 MPa for 4 days. We will evaluate the effects of the composition of host plagioclase (An content) on the progress of replacement and resulting pore generation.

Keywords: micro-nano pores, feldspar replacement, potassium-rich fluid, fluid infiltration, hydrothermal experiment

