Porosity generation during feldspar replacement as the mark of potassium-rich supercritical fluids on the top of granitic intrusion

*Astin Nurdiana[1], Atsushi Okamoto[1], Masaoki Uno[1], Kenta Yoshida[2], Noriyoshi Tsuchiya[1]

1. Tohoku University, 2. Japan Agency for Marine-earth Science and Technology

Feldspar replacement is prevalent process within the crust which has been studied for decades. In particular, it is known that feldspar is texturally sensitive to an interaction with fluids, and the process often results in by the pore generation. Recently, Plümper, et al. (2017) proposed that such reaction-induced nanoporosity plays significant roles in pervasive fluid flow in the crusts, yet it is still unclear until what extent nanoporosity commonly presents and is affected by the feldspar replacement. In this study, we report novel pore structures that have been produced during feldspar replacement in the hornblende schist around the granitoid body.

The Kinkasan Island, which is part of southern Kitakami Mountains, mainly consists of the Cretaceous granitoid bodies with abundant pegmatite dikes, and metamorphic sequences, including hornblende (Hbl) schists and biotite schists. Quartz diorite, as the host plutonic body, and metamorphic rocks were formed under the conditions estimated to be 700-750°C and 610-660°C in 0.37-0.42 GPa, respectively. The Hbl schists are often cut by thin alkali feldspar veins in direction perpendicular to the foliation. In the matrix, primordial plagioclase grains (An48Ab52Or0) are generally replaced by patchy grains of albite (An4Ab94Or2) and alkali feldspar (An0Ab1Or99). The mass balance analyses of the plagioclase and alteration products show the gains of Si, K, and fewer Na, also loss of Ca and Al, indicating that feldspar replacement was induced by infiltration of the potassium-rich fluids (the K/Na molar ratio of 3). The detail observations by FIB-SEM reveal that the replacement process yields extensive amount of pore with throat size of ~0.1 –5 μm. These pores preferentially formed along the grain boundaries of newly-produced albite. Generally, the pores distribute throughout all the plagioclase grains without preference for matrix grain boundary, and formed 3D pore network that seems barely to continue. However, it increased the porosity of the rock up to ~2%. These features of pores related to the feldspar replacement suggests the importance of the reactive fluid infiltration through low-permeability metamorphic rocks, likewise give a new insight on how fluid propagation generate micro-to nano-scale porosity.

Reference: Plümper et al., 2017. Nature geoscience, 10, 685-690.

Keywords: feldspar replacement, pore network, potassium-rich fluids, fluid transport, FIB-SEM

