Formation of Sodium-rich, High-Mg# Melt by Reaction of Felsic Melt with Peridotite: Implications from Felsic Veins Observed in the Magarisawa Peridotite, Hidaka Mountains, Northern Japan

*Kohei Yamashita[1,2], Jinichiro Maeda[3], Masako Yoshikawa[4], Tomoyuki Shibata[4], Toru Yamasaki[2]

1.Department of Natural History Sciences, Graduate School of Science, Hokkaido University, 2.Research Institute of Geology and Geoinformation, Geological Survey of Japan, AIST, 3.Department of Natural History Sciences, Faculty of Science, Hokkaido University, 4.Beppu Geothermal Research Laboratory, Kyoto University

Origin of Na-rich felsic veins and pools which are rarely found in sub-arc mantle xenoliths (e.g., Shimizu et al., 2004) has been controversial. Some authors have suggested that they are trapped Na-rich slab melt (e.g., Kepezhinskas et al., 1995), whereas others suggest that their Na-rich nature is attributed to reaction of felsic melt and mantle peridotites (e.g., Prouteau et al., 2001).
Felsic veins of various widths (microscopic order to ca. 50–60 cm) and lithologies are observed in the Magarisawa Peridotite (the MP) which is composed mainly of Pl lherzolite, northern Hidaka Mountains, Hokkaido (Yamashita et al., 2015, JpGU abstract). We discuss chemical modification process, particularly Na-enrichment of the felsic melts due to reaction with the MP.
The felsic veins are subdivided into four facies: 2Px Granite (Qz+Kfs+Pl+Opx+Cpx); Opx Monzodiorite (Qz+Kfs+Pl+Opx); Norite (Pl+Opx); Pl-veinlet (Pl+Opx), which is branched from 2Px Granite or Opx Monzodiorite. Microscopic characteristics and whole rock compositions suggest that 2Px Granite and Opx Monzodiorite preserve melt compositions and that Norite and Pl-veinlet represent Pl-Opx cumulates.
Sr and Nd initial ratios of all these veins are similar and correspond to those of the pelitic granulite/anatexite surrounding the MP (Maeda and Kagami, 1996). It suggests that all felsic veins have formed from partial melt of the pelitic granulite.
It is noted that the Opx Monzodiorite is characterized by especially high-Na_2O content and -Mg# (6-7 wt% and 74-82, respectively). It also shows relatively high-SiO_2 content (62-64 wt%). Experimental partial melt of pelitic granulites opposed at southern Hidaka Mountains (Osanai et al., 1997 in Japanese), which is expect to have similar compositions to the initial melt forming the Opx Monzodiorite, show much lower Na_2O content and Mg# than the Opx Monzodiorite. It suggests that partial melt of the pelitic granulite have experienced marked chemical modification within the MP. Possible chemical modification processes are fractional crystallization of Pl+Opx (i.e., Norite or Pl-veinlet) and the initial melt-peridotite reaction. However, because the Opx Monzodiorite shows no Eu anomaly, it seems to have never experienced fractional crystallization of Pl. Thus, latter process is probable.
Opx-wall, reaction zones (ca. 1 mm in width) composed of secondary Opx is always formed along vein-peridotite boundary. Phl is characteristically formed between the Opx Monzodiorite vein and Opx-wall. On the other hand, between Opx-wall and Pl-veinlet which is branched from the Opx Monzodiorite, high-Ca# Pl (Ca#~90) + vermicular Opx±Phl with ca. 1 mm in width (vermicular zone) is always formed.
Based on the results of this study, we propose the process how Na-rich, high-Mg# (Opx Monzodioritic) melt have formed by reaction between felsic melt and peridotite, occurred within the MP:
(1) Initial SiO_2-rich melt (melt1) intrudes into peridotite, followed by the formation of Opx-wall along melt1/peridotite boundary;

(2) Concurrently with (1), because of diffusion of Mg and Fe from peridotite into melt1, relatively SiO_2-poor melt (melt2) is locally formed between melt1 and peridotite;
(3) When diffusion between SiO_2-rich melt and SiO_2-poor melt occurs, alkalis diffuse from latter to former (uphill diffusion: e.g., Sato, 1975). By this process, Na (and K) may diffuse from SiO_2-poor melt2 to SiO_2-rich melt1 against concentration gradients of alkalis (melt1 > melt2). Elements except for Na and K (e.g., Si, Mg, Fe and Ca) diffuse according to the concentration gradient;
(4) Finally, Na_2O (and K_2O) contents and Mg# of melt1 become higher than initial melt. Vermicular zone, including high-Ca# Pl, may represent the composition of melt2 which become lower Na_2O than initial composition.

Keywords: felsic melt-peridotite reaction, uphill diffusion, Hidaka Magmatic Belt

