Lawsonite-blueschist facies metamorphic rocks as a reservoir of H2O: a case study from the Kamuikotan metamorphic rocks in the Horokanai area, Hokkaido

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Deep-fluid activity in subduction zones attracts the attention earth from scientists as deep-fluids control various phenomena such as slab seismicity and arc magmatism. High P/T type metamorphic rocks formed at past and present subduction zones contain a significant amount of water in hydrous minerals and therefore represent valuable tools for understanding deep fluid activity in subduction zones. For example, lawsonite (Lws)-blueschists act as a water reservoir and their transformation to epidote (Ep)-blueschist or eclogite can result in massive H_2O supply to the surrounding rocks (e.g., Hacker et al., 2003; Yoshida et al., 2015: Sato et al. 2016).

Previous studies of the Kamuikotan metamorphic rocks (KMR) in the Horokanai area, Hokkaido, proposed that Lws breakdown and the subsequent formation of Ep-blueschist took place during prograde metamorphism (Shibakusa, 1989; Sakakibara and Ota, 1994). According to this idea, a large amount of H_2O should have been generated by Lws breakdown. In order to elucidate the nature of the released fluid, Minagawa (2012) and Kataoka (2014) carried out geologic and petrographic surveys in the same area, and pointed out that Lws breakdown texture into Ep was not found from metabasite in zone II (Lws and Ep-bearing zone) and zone III (Lws-free and Ep-bearing zone) of Shibakusa (1989).

Our study focused on the reconfirmation of the metamorphic zoning proposed by Shibakusa (1989) in order to clarify the formation history of diagnostic minerals. No Lws breakdown texture was detected across the study area. On the other hand, we infer that the growth of Lws porphyroblast took place under the same stress regime as that associated with the formation of the Ep- and Na-amphibole-bearing main foliation. In addition, the XFe {=Fe/(Fe+Mg)} values of Na-amphibole and chlorite in Lws-free samples are distinctively high compared to those from the adjacent Lws-bearing samples, indicating that the appearance of Lws in blueschist in the study area is controlled by the XFe of the protolith. Consequently, Lws can be stable even in the highest grade part of the study area.

The following low-variance mineral assemblages are identified in metabasites in the higher grade part of the study area; (1) Ep + sodic amphibole (Na-amp) + chlorite (Chl) + Lws, (2) Ep + Na-amp + Chl + Lws + sodic pyroxene (Na-px), (3) Ep + Na-amp + Chl + Lws + Na-px + hematite (Hm), (4) Ep + Na-amp + Chl + Lws + pumpellyite (Pmp), (5) Ep + Na-amp + Chl + Na-px and (6) Ep + Na-amp + Chl + Pmp + actinolite (Act).

Lws-bearing and Lws-free assemblages roughly correspond to the representative assemblages of zones II and III of Shibakusa (1989), respectively. However, such assemblages occur almost next to each other, without evidence that they define distinct metamorphic zones.

The stability conditions of the above mentioned mineral assemblages are analyzed with Schreinemaker's method in the NaCaMgFe3+AlSiH system. Assemblages (2), (3), (4), and (6) correspond to following univariant reactions: (F1) Na-amp + Lws + Na-px = Ep + Chl + H2O, (F2) Lws + Na-px = Ep + Chl + Hm +

H2O, (F3) Na-amp + Lws = Pmp + Ep + Chl + H2O and (F4) Na-amp + Pmp = Ep + Act + Chl + H2O.

These reactions take place in a relatively narrow P-T interval, and assemblages (1) and (5) are also stable around these reactions. The P-T intervals correspond to the boundary region between the Lws-, Pmp- and Ep-blueschist sub-facies, in other words to the uppermost P-T conditions of the Pmp-blueschist sub-facies.

Mineral assemblages from zone I (Ep-free zone) of Shibakusa (1989) are stable around the following reaction: (F5) Na-amp + Lws = Pmp + Na-px + Chl + H2O, which occurs on the low P/T side of reaction F3. The areal distribution of Na-amp + Lws assemblages is limited to the structurally upper levels, i.e. in the neighborhood of Ep-bearing rocks. As a conclusion, the KMR in the study area are considered to have played the role of a H_2O reservoir in the cold, Cretaceous subduction system.

Keywords: lawsonite, blueschist, H2O reservoir, Horokanai, Kamuikotan metamorphic belt

