Magmatic processes of the largest silicic eruption (Ak2) from Akan caldera, eastern Hokkaido: Comparing with the other eruptions

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Three caldera volcanoes, Akan, Kutcharo and Mashu, are clustered at the eastern Hokkaido, Japan. Akan caldera has been formed by related pyroclastic flows and plinian eruptions during 1.7 ˜0.2 Ma. These pyroclastic deposits can be divided on the basis of intervening paleosols into 40 eruptions, which can be also grouped into 17 eruptive groups (Ak1-Ak17 in ascending order) by significant time intervals such as 30 cm thick paleosols and unconformity. Ak2 is the largest eruptive group (over 50 km3DRE), whereas estimated volumes of most of other groups are under 10 km3DRE. In this study, we investigated magma processes of Ak1-Ak9, which are well preserved and can provide detailed geological and petrological information.

Juvenile materials of Ak1-Ak9 are composed of dominant white or gray pumice and minor amount of scoria and banded pumice. Crystal contents (wt.%) of Ak2 and Ak1 are 8-17%, whereas those of other eruptive groups are under 8%. Common phenocryst minerals are plagioclase, augite, hypersthene and Fe-Ti oxides. In whole-rock compositions of SiO2 (wt.%), Ak2 shows a wider range (60-73%) than that of the other groups. On K2O Harker diagram, each stage shows nearly parallel and different trend, and Ak2 is characterized by the largest value of K2O at a given SiO2 contents (SiO2=70%: K2O =2.4%). In MgO, Zr and Ba Harker diagrams, Ak2 shows various compositions of these elements at the silicic side. These characteristics are common to glass compositions. We also determined mineral, REE and isotopic compositions of the most silicic samples of Ak1-Ak9. Or contents (mol%) of plagioclase cores of Ak2 are more than 1.2, whereas those of the other groups are less than 1.0. Mg# of pyroxene cores of Ak2 (Opx=45-59, Cpx=49-60) are smaller and broader than those of the other groups. LogfO2 of Ak2 and the other groups are plotted under and over QFM buffer line, respectively. Ak2 shows the steepest LREE enriched pattern. Moreover, Ak2 has relatively enriched compositions of 87/86Sr (0.7033-0.7035) and 143/144Nd values (0.51294-0.51297) when compared with those of other groups.

Different parallel trends of each group on the K2O Harker diagram suggest that distinct magma systems were existed among the eruptive stages. Compositional variations of SiO2-MgO, -Zr and Ba of Ak2 match with the variations of all other groups. Furthermore, Compositional ranges of Mg# of pyroxene cores of Ak2 rhyolite also comparable with that range of all other groups. These suggest that several distinct silicic magmas, which could make the chemical variations of several eruptive groups, were ejected at the same time in the Ak2 eruption event. This suggestion is well consistent with the largest volume of Ak2 and the longest dormancy before Ak2 (more than 200 ky). In Akan caldera, different magmas were repeatedly renewed from group to group. However, there existed particularly long preparation period before Ak2 eruption, and several distinct magmas could stagnate together at that time. During the time, crystallization might be carried out, resulting in the high crystal contents of Ak2. The other petrological characteristics of Ak2 can be interpreted as the result of remelting or assimilation of relatively enriched crust materials at the long period. In this period, adjust Kutcharo volcano started the caldera-forming activity that might be associated with the anomalous Ak2 event.