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The Petrological Study of Tokachidake Volcano: Especially about the Magma System of 20th Century Activities

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Tokachi-dake is an active volcano located in the central part of Tokachi-dake Volcanic Group. Volcanic activity of the group, started ca. 1 Ma, consists of three stages; Older, Middle and Younger stages (Ishizuka *et al*., 2010). Tokachi-dake volcano mainly formed in Younger stage, and has erupted with changing its eruptive craters since ca. 4700 years ago. According to volcanic dormancy, locations of eruptive center, and petrological features of ejecta, the activity of the volcano is divided into Stages 1-4 (Fujiwara *et al*., 2007, 2009).The 20th century activities, including 1926, 1962, and 1988-89 eruptions, belong to Stage 4. These three eruptions have been extensively investigated in terms of eruption processes (e.g., Tada and Tsuya, 1926; Katsui *et al*., 1963; Katsui *et al*., 1990). However, there were few petrological studies on the ejecta and magmatic processes have not been examined in detail, in spite of the importance in predicting the future volcanic activity.

In this study, a petrological study is carried out on ejecta of the three 20th-century eruptions to elucidate the evolution of magmatic system beneath the volcano. About 50 samples collected newly from the volcano, as well as 50 samples stored in Hokkaido University, were used for petrological analysis. The ejecta of three eruptions are basaltic andesite in composition, and contain olivine, orthopyroxene, clinopyroxene, plagioclase, and Fe-Ti oxide phenocrysts. The abundance of the phenocrysts is 26-47%, 36-43%, and 43-48% in 1926, 1962, and 1988-89samples, respectively. The groundmass of the 1926 scoria is heterogeneous in texture, whereas that of the 1962 scoria is homogeneous. The 1988-89 ejecta are characterized by high crystallinity in the groundmass and the presence of many olivine phenocrysts with reaction rim of pyroxene. Whole-rock compositions are essentially homogeneous in the 20th century ejecta, but Ti, Al and V contents in the 1962 products differ slightly from those in the 1988-89 ejecta. In a histogram of the cores of the olivine phenocrysts, bimodal peaks are observed at Fo=71 and 75 in the 1926 products, whereas unimodal peak is present at Fo=76 in the 1962 and 1988-89 ejecta. Mineralogical features of the pyroxene phenocrysts are essentially common in the three eruptive products, ranging from Mg#=68-77 in clinopyroxene and Mg#=66-75 in orthopyroxene, while those in the 1988-1989 volcanic bomb samples are relatively low in Mg#. Fe-Ti oxides have a compositional peak at Mg/Mn=˜15 in 1926 and 1962 scoria, but the rim of those in the 1988-89 volcanic bomb have lower Mg/Mn of ˜8. The An of the plagioclase phenocrysts ranges from 56 to 92. Reversely zoned pyroxene and plagioclase phenocrysts are dominant in the 1926 ejecta, but they are scarce in the 1962 and 1988-89 products.

The 1926 scoria have many plagioclase and pyroxene phenocrysts with reverse zoning, and the groundmass is heterogeneous in texture; these observations suggest that magma mixing occured immediately before the 1926 eruption. On the other hand, the 1962 magma did not experience a significant magma mixing event, as inferred from the relatively homogeneous texture in the groundmass. The whole-rock compositions of the 1926 and 1962 ejecta are essentially similar, but the plagioclase phenocrysts commonly show normal zoning unlike the 1926 products. These observations may indicate that the 1962 magma was derived from a portion which is different from the 1926 magma in the same magma chamber. The 1988-89 ejecta are relatively higher in the crystallinity of the phenocryst phases, suggesting that the temperature of the 1988-89 magma was lower than that of the 1962 magma. Considering that the rims of the Fe-Ti oxides are characteristically lower in Mg/Mn, relatively low-temperature magma may have been slightly mixed in the 1988-89 magma shortly before eruption.

Keywords: Tokachidake Volcano, Magma Plumbing System, Petrology