

Standard stratigraphy and characteristic properties of late Quaternary tephras on the Niijima-island: Report of geochemistry and refractive indices of volcanic glass shards, orthopyroxene, hornblende, and cummingtonite

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Tokyo Metropolis has the twenty-three wards, the Tama district, and the islands area. The population of the islands area is 25,353 (1st January 2019). The islands area, namely, the Izu-Ogasawara Islands consist of 21 volcanoes (islands and submarine volcanoes), excluding some islands. For residents in this area, volcanic disasters are always the threat. Accordingly, to integrate the fundamental information for preventing volcanic disasters, we investigate the history of volcanic activities, the pattern of each eruption, and the mass volume of erupted tephras and try to establish the high-resolution tephrochronology (Kobayashi *et al.*, 2019a,b). This project focuses on establishing the database of tephras collected from each island of the Izu Islands and their petrographic description and geochemical data. Also, it is likely that such tephra across the sea would deposit in the hemipelagic sediment around volcanic islands. Our tephra database of the Izu Islands has been a powerful tool to identify the source of marine tephra bearing in drilled core CK09-03,C9010E collected at the site of 100 km east from the Izu Island, off the Boso Peninsula (Aoki *et al.*, 2019). Today, we present the petrographic and geochemical characters of many tephras provided through volcanic activities of the Niijima island during late Quaternary.

At the Daisan-yama, Fujimi Touge, and Miyatsukayama on Niijima island, and also Jinaijima off 1.6km west of Niijima island, we have recognized 21 eruptive events at least, including some tephras derived from off-island (Kobayashi *et al.*, 2019a). Kobayashi *et al.* (2019a) recognized as Niijima Origin tephra felsic magma events and mafic magma events on Niijima island. On the island, as widespread marker tephra, AT and K-Ah tephra were detected. After tephra samples were washed by the ultrasonic cleaner, we collected the description of petrographic characters, major-element chemistry determined by EDS and refractive indices (RI) of volcanic glass shards, orthopyroxene, hornblende, and cummingtonite in each tephra. Generally, felsic tephra derived from vents on the Niijima island include often a small amount scoria grain. Most felsic tephras consist of felsic volcanic glass shards, and including plagioclase, quartz (including β -quartz), orthopyroxene, hornblende, cummingtonite, and occasionally biotite. The characteristic fact of Niijima Origin tephra is that RIs of heavy minerals (orthopyroxene and hornblende) has broad variations. Especially, RIs of orthopyroxene in Akasakimine tephra series, Miyatsukayama tephra series, and Miyatsukayama Nannbu tephra series show the bimodal or trimodal histograms within the limit of 1.700-1.730, including high RIs over 1.730 slightly, considered as close to ferrosilite. Also, there is the tendency that RIs of hornblende in Akasakimine tephra series and Miyatsukayama tephra series show the bimodal histograms or broad variations within the limit of 1.663-1.688. On the other hand, RIs of cummingtonite in Niijima Origin tephra during 60 ka show the unimodal histograms within the limit of 1.658-1.669. RIs of felsic volcanic glass shards in Niijima Origin tephra show within the limit of 1.492-1.501. By comparison that common range of RIs on Quaternary tephra in Japan is 1.501-1.505 (Machida and Arai, 1992), RIs of Niijima Origin tephra would be classified to lower RI groups in Japanese Quaternary tephras.

The content of SiO_2 in volcanic glass shards is 77.7-78.2 wt%, $\text{Na}_2\text{O}+\text{K}_2\text{O}$ is 7.2-7.7 wt% generally, excluding some tephra which range is within the limit of 7.0-8.3 wt%. The content of FeO^* is 0.7-1.0 wt% and high- SiO_2 is harmonious to the lower RIs of volcanic glass shards (Furuta *et al.*, 1986; Kikkawa, 1990).

Keywords: Izu, Niijima, tephrochronology, petrographic characters, major-element composition