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Temporal color variations of volcanic ashes from Aso Nakadake 2014-2015

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Current eruptive activity of a crater of Nakadake in Aso volcano, since 25th November 2014, provides frequent sampling of fresh magma. In order to understand the time variation of dehydration and oxidation process of magma during ash eruption, we focused on the color of the volcanic ash. We separated a finer (silt size or less in diameter) composition in the volcanic ash by elutriation and measured the color using a color-meter (Minolta SPAD-503). In addition, we measured the colors of a coarser component (0.25-0.5mm in diameter by sieving) in the volcanic ash after grinding for about 30 minutes in an agate mortar. The measured color data will be reported in the L∗a∗b∗color space defined by the CIE (1976). Systematic temporal change was observed over time in the a∗value (redness) for a finer component of volcanic ash samples. The a∗value of the volcanic ash samples showed a clear temporal variation; the redness increased significantly at the beginning of the observation period. Thereafter the redness appears to be reduced while oscillating. Specifically, a∗value is significantly increased from 0.3 to 6.7 through 4th December from 25th November, 2014, significantly decreased from 6.7 to 1.7 through 24th December, a slight increase from 1.7 to 2.5 over 27th December, minimum at 0.6 to 14th January, 2015, a slight increase from 0.6 to 1.5 over 16th January, gradually decline from 1.5 to 1.2 through 19th January, and in 28th January there was a slight increase from 1.2 to 1.6. In contrast the observation in coarse component of volcanic ash that a∗value of fine components have increased significantly over 4th December from 25th November, a∗value of the coarse-grained components have decreased from 0.94 (29th November) to 0.44 (3th December). The observed color change is by oxidation of iron in volcanic ash with atmospheric oxygen (Miyagi and Tomiya, 2002, J.Volc.Soc.Jpn.) and/or with oxidation due to hydrogen degassing (Miyagi et al., 1999; Geochem J.). Since a volcanic plume entraps a large amount of air, the plume temperature drops rapidly below 300 degree-C. As a result, time for iron oxidation in the plume temperature is only limited. Therefore, oxidation of volcanic ash particles occurs selectively for fines component that has a large specific surface area. On the other hand, the oxidation by dehydrogenation can happen in the volcanic conduit where atmospheric oxygen does not flow into. Therefore, color of the fine volcanic ash particles probably record the temperature of the plume. And the color of the coarse-grained volcanic ash particles may reflect the oxidation state of the magma in a volcanic conduit before eruption (Miyagi et al., 2010, Volcano). To the early December from the end of November, the color of fine grain volcanic ash changed to oxidative, and the color of coarse grain changed to a reductive. These observations can be interpreted as reflecting an increase in reductive magma supply and an increase in plume temperature. Since mid-December, volcanic ash contain relatively large amounts (>40%) of magmatic particles such as pale brown glass. Volcanic cloud is expected to be high temperature. However, the a∗value of fine grained ash keeps a low value. We guess that the actual plume temperature is lower than expected, or there exist mechanisms to inhibit the oxidation of the ash particles. We would like to thank the Japan Meteorological Agency (JMA) and to the Aso volcano observatory Kyoto university for their help in sampling.

Keywords: Aso, Nakadake, volcanic ash, color, oxidation, temperature