Stratigraphic characteristics and inferred eruption sequence of AD1895 phreatic explosion of the Zao volcano, NE Japan

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The Okama erupted at AD1895, that was a series of phreatic explosions. The products are well preserved, however any volcanologic researches have not been performed on this eruption, except for the documentation of Kochibe (1896).

The crater lake Okama situates in the Umanose caldera. The products of the Zao AD1895 phreatic explosion consist of hydrothermal altered gray colored matrix with various amounts of altered lithic fragments, andesites and scoria, except for layer 1a. The AD1895 deposits can be found over an area with a diameter of 2 km around the crater. The deposit is divided lithologically into 5 layers. Most of the layers are observable in the vicinity of the Okama crater, although the thickness of these layers vary, tending thinner away from the Okama crater. The products are best preserved at the southwestern rim of the Okama crater, with the total thickness of 5 m (type locality). At this outcrop, layer 1 is divided into three sub-layers (a, b, c). The layer 1a and 1b have thickness of 6 and 1 cm, respectively. These are composed of scoriaceous volcanic sand, and white colored fine clay. Both the layers are well sorted. The layer 1c, 2 and 3 have thicknesses of 4, 5 and 25 cm, respectively, and are matrix supported, weakly laminated, poorly sorted. The lamination in layer 3 tends to become less well-defined upward. Altered lithic fragments and scoria in these three layers are less than 20 wt% in amount, and are smaller than lapilli size. Bomb-sag structures are observed in the lower part of layer 1c. While layer 1c and 3 have pale gray colored matrix, layer 2 has white gray colored one. Both the upper and lower surfaces of layer 2 are sharp and usually undulating. Layer 2 gets thinner than layer 1c at the summit of Goshikidake. In the upper part of the layer 1c at the outcrop of 100 m west from the type locality, 3 cm thickness layer composed of the accretionary lapilli (1 mm in diameter) can be observed. Layer 4 covers layer 3 and layer 5 covers layer 4 with not sharp but gradational or wavy contacts at the type locality and the vicinity area. Layer 4 and 5 are very poorly sorted and matrix-supported tuff breccia, with thicknesses of 68 cm and more than 300 cm, respectively. Lithic fragments and accessory scoria larger than lapilli size are common in these layers, and are particularly abundant in layer 5. The elongated clasts in layer 5 are up to 50 cm in size, and are horizontally aligned. The amounts of the altered lithic fragments and accessory scoria smaller than lapilli size are 45 wt% in layer 4 and 60 wt% in layer 5 at the type locality. The weak grading of the lithic fragments and accessory scoria can be observed repeatedly.

By the documentation, it is deduced that the explosions took place in Feb. 15, 19, Aug. 22 and Sept. 27, 28 of AD1895. A news paper reported that it hailed on Feb. 19, suggesting that the accretionary lapilli fell out around the Zao volcano. The upper part of layer 1c would have composed of these accretionary lapilli. Therefore, it is inferred that layer 1b was formed in the eruption of Feb. 15. Kochibe (1896) described that the mountain threw the white smoke into the air on Feb. 15. Thus, the phreatic explosion would have taken place on Feb. 15. Consequently, the layer 1a would be formed by the eruption in AD1894. The news paper reported that the ashes fell in Yamagata city enormously by the explosion on Aug. 22. Thus, it is probable that both the layer 2 and 3 deposited on Aug. 22. In the sketch of the explosion on Sept. 27, Kochibe (1896) clearly showed fragments falling down from the eruption column with an umbrella part developing at the top. We inferred that the column-margin fall produced the large lithic fragment-enriched layer 4 and 5. In the documentation of Kochibe (1896), scoria (30 cm in diameter) which ejected from the Okama crater on Sept. 28 reached to the outside of Umanose caldera.