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Characterization of the low-temperature pyroclastic surge occurred in the late 19th century of northeastern Japan arc

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We re-examined and restructured the sequence of the Bandai 1888 and Adatara 1900, and Zao 1895 phreatic eruptions, in order to reveal the detailed nature of the low-temperature pyroclastic surge phenomena. The high-resolution restructuring of the eruption sequences was performed by crosschecking the geological data of the surge deposits with old documents including the reports of newspapers. Physical parameters such as explosion energy, volume of the surge deposit, and size of crater (or minimum width of the anphitheater) were also estimated and/or researched for the eruptions. These are: 6.5×10^{15}J, 1×10^{7}m^{3}, and 1000m for the Bandai 1888, 6×10^{13}J, 2.9×10^{5}m^{3}, and 300x150m for the Adatara 1900, and 8.8×10^{10}J, roughly 10^{3}m^{3}, and 30m for the Zao 1895, respectively. Further, the velocity, excess pressure, and temperature of the surge were roughly inferred from the reports and testimonies of damages caused by the surges. The inferred values are: 80-140m/sec 8-20 kPa, and less than 100 C for the Bandai 1888, 80-130 m/sec, 4-10 kPa, and around 100 but less than 230 C for the Adatara 1900, respectively.

Comparison of the three phreatic explosions revealed the common features which must be the essential clues to elucidate the flowage and depositional modes of the low-temperature pyroclastic surge, and relevant textures in the resultant surge deposits. These include: (1) apron-like distribution of up to several hundred meter in diameter, with exceptional elongation along the valley, (2) roughly typical pyroclastic surge characteristics on the average grain-size vs. sorting diagram, (3) a pyroclastic surge is first recognized as spreading of low-density, high-velocity pyroclastic current just like black smoke or blast wind, which is followed by denser, relatively slow pyroclastic density current, that is recognized as a pair of lower, fine-laminated and upper coarse-massive layers, (4) poorly sorted, fine-grained, and accretionary lapilli-bearing ash deposit is dominant in the distal area, irrespective of the depositional modes. Also, comparison of physical parameters of these explosions along with the MSH 1980 eruptions proved that the cube-root scaling law which is confirmed on the bases of the field explosion experiment is well-applicable to the natural phreatic explosions, whose explosion energies range from 10^{11} to 10^{15} J. The data presented in this paper must be the first series of evidence for the successful application of the energy estimating method based on the cube-root scaling law (eg. Goto et al., 2001; Ohba et al., 2002) to the natural volcanic explosions.