Characterization of the so-called blast-derived surge occurred at Bandai 1888, Adatara 1900 and Mt. St. Helens 1980 eruptions

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The more detailed geological and historical investigations are needed for particular historic volcanic explosion(s), in order to utilize and apply the experimental result adequately to the real volcanic eruption. Not only the detailed documents of the field research immediately after the eruptions, testimonies of the eyewitness and survivors are also powerful tools to understand the phenomena correctly. Based on the concept mentioned above, we re-surveyed and characterized the Bandai 1888, Adatara 1900 so-called blast-derived surge phenomena and compared them to that of Mt. St. Helens 1980.

While the phreatic explosion at cramped area caused the directed blast in the case of Adatara 1900 eruption, sector collapse of the edifice induced the surge in the cases of Mt. St. Helens 1980 eruption. In the case of Bandai 1888, the surge was derived by phreatic eruption, which may have triggered sector collapse. These surge events are thought as a sort of base surge whose volcaniclastic materials were mainly or totally derived from the pre-existed edifices (accessory materials), although considerable amount of juvenile fragments (fragment of hot magma) are recognized in the deposit of Mt. St. Helens 1980 surge. Volumetric estimation of the surge deposits gives 0.01 cubic km for Bandai 1888, 0.0003 cubic km for Adatara 1900, and 0.2 cubic km for Mt. St. Helens 1980 eruptions.

By combining the documents and the testimonies with the field observation of the volcaniclastic deposits, recognized are 3 flow units of surge for the Adatara 1900 eruption, 1 flow unit for Mt. St. Helens 1980, and probably 2 flow units for Bandai 1888 eruptions, respectively. Each flow unit consists of several layers (or depositional units) showing distinctive textural features.

Several common geological and stratigraphical features are recognized in Adatara 1900 and Mt. St. Helens 1980. These include: dominant massive layer with its underlying blast deposit (containing fragments of wood, house and chinaware and regolith) in the proximal part, stratification of massive layer and overlying bedded surge layer with or without ash bed on the top of the stratification in intermediate part, and thin fine ash beds with accretionary lapilli in the distal part. From these, we are able to envisage the generalized flow characters of the base surge preceded by blast. It can be regarded as a high-velocity, low temperature, and relatively diluted member of the pyroclastic density flow clan. In the case of Bandai 1888, the blast layers are unclear.

The explosion energy was estimated on the basis of the resultant crater diameter, assuming that the cube root scaling law was applicable to the estimation (Goto et al., 2001). The results of estimation are 20,000,000,000,000,000 J for Bandai 1888, 60,000,000,000,000 J for Adatara 1900, and 100,000,000,000,000,000 J for Mt. St. Helens 1980 eruptions, suggesting that the volume of the resultant surge deposit is roughly proportional to the discharged energy of the explosion.