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Mechanism of the 1888 Phreatic Explosion at Bandai Volcano, 3. Location of Explosive Source and Multi-directed Outbursts

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The eruption at Bandai volcano in 1888 has been known as one of the most gigantic phreatic explosions. The details of this eruptive process as well as the seismic precursory have been collected by the local habitants around the volcano. The eruptive mechanism has been studied on the basis of old documents such as eyewitnesses, sketches and photographs. However, the lacking of underground data has led volcanologists into some misconstructions and unclear understanding of the processes until now. We looked back on the basic factor in the phreatic outbursts based on the informations both from the 3D shallow structure and from the seismic activities that were obtained after one century since the eruption.

Sekiya and Kikuchi (1890) reported that the phreatic explosions occurred almost simultaneously to the directions of up-, north- and southeast-wards. The upward directed explosion followed one after another in 15 to 20 times. The northward one discharged horizontally a large quantity of debris avalanche that was triggered by the mountain collapse. Terrible blast of winds in addition to high speed mud stream burst downward to the southeast along the Biwasa valley. Sekiya and Kikuchi (1890) explained that the phreatic materials were stored beneath Kobandai-san and that the flows of outburst happened at the same place and took merely different routs. This likely explanation has been received as a commonly accepted model for the explosive process and has been cited in many articles (e.g. Moriya, 1980). However, several observed facts seem to be out of harmony with this model.

In this study, referring the 3D velocity structure (Yamawaki et al., 2004) and the recent seismic activities (Nishimura et al., 2002), the explosive source was modeled by a pressurized cavity in a semi-infinite elastic body. The internal pressure in a cavity produces characteristic stress distribution along the periphery of cavity and also along the free surface (Savin, 1961).

Two maximum tensile stresses are induced locally in this model. The one maximum tensile stress is located on the free surface just above the apex of the cavity and the other does on the periphery of the cavity. The latter position is determined by the ratio d/r, where r is the radius of the cavity and d is the distance to its center from the free surface. Appling this model to the actual velocity structure, the projected position (point A) of the apex onto the free surface is located at Numano-taira about 500m NE-ward from the summit of Obandai-san. By reference to the spatial distribution of the asismic region, the parameters of d and r are fixed to be 1km and 0.5km respectively and the maximum tensile stress along the periphery is estimated to be at a horizontal distance of about 430m from the point A. This position in NS- or EW- cross section is close to either the starting point of a linear stream-fissure inside the newly formed caldera or Hikage-crater (Wada, 1888) on the eastern edge of Numano-taira, respectively. The former is the starting point of massive avalanche toward north and the latter is the breaking open of violent outburst of wind toward southeast along Biwa-sawa.

We conclude that the phreatic pressurized chamber related to the 1888 explosion is not located beneath Kobandai-san (newly formed crater) but just beneath the Numano-taira (ancient crater), from this spot the outbursts were issued to different directions.

Keywords: Bandai volcano, Phreatic explosion, Directed blast, Blast of wind