Mixing and degassing of magmas in the 10th Century Eruption of Baitoushan Volcano, China/North Korea

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The eruption mechanism of large eruptions which are accompanied by caldera formation is yet poorly understood. Baitoushan volcano, China/North Korea, is one of the most active volcanoes in Northeastern Asia, and the 10th century eruption with caldera formation as large as 10 km in diameter was one of the most voluminous eruptions in the world in recent 2000 years. Here we present preliminary results and some implications on the mechanism of this eruption.

The sequence of the eruption reconstructed recently consists mainly of 6 units of deposits, unit B to unit G in ascending order (Miyamoto et al., 2004), and is subdivided in two phases, Phase 1 (unit B-C) and Phase 2 (unit D-G), in terms of dispersal characteristics. Phase 1: Unit B is a plinian airfall deposit which has a dispersal axis eastwards. Unit C is a voluminous pyroclastic flow which deposited almost all the directions from the vent area but thickest in southeast area. Phase 2: Unit D is characterized by alternation of plinian airfall and intra-plinian pyroclastic flow deposits which has a dispersal axis northeastwards. Unit E is a sub-plinian airfall deposit which is distributed to the north from the vent area. Unit F consists of several pyroclastic flow deposits that distributed in valleys in the proximal area. Unit G is characterized by base surge deposit which is only recognizable in the caldera. In the present study, we investigated the juvenile materials of this eruption sequentially in terms of whole rock, matrix glass and mineral compositions, vesicularity, H2O content in the matrix glass and textural characteristics in order to discuss ascent processes of magma during eruption.

The whole rock, glass and mineral compositions change simultaneously with eruptive phenomena. The magmas erupted during steady eruptions in earlier phase (comendite; unit B-C; Phase 1) and in later phase (trachyte; unit E; Phase 2) were homogeneous, whereas the magmas during fluctuating eruptions in later phase were characterized by wide range of composition from trachyte to comendite (unit D, F-G; Phase 2). The wide variety in composition and occurrence of banded pumices strongly indicate mixing or mingling of two to three magmas just prior to or during the eruption.

The initial water contents had been determined for comendite by melt inclusion analyses (ca. 5.2 wt.%; Horn and Schmincke, 2000). The water contents of trachytic melt inclusions are lower (3-4 wt.%; Horn and Schmincke, 2000) which would represent the initial water content of the trachytic magma. The vesicularity of pumices are generally high (ca. 0.8) for all units. The residual water contents of the pyroclasts during Units B-C and E are relatively uniform (1.6 wt.% and 0.8 wt. %, respectively), and the relationship between the initial and final water contents and vesicularity can be accounted for by equilibrium vesiculation in closed systems. In contrast, residual water content of the pyroclasts during Phase 2 except unit E are heterogeneous (ca. 0.7-2.0 wt.%). These facts indicate that the heterogeneous mixing or mingling may be one of the significant processes that resulted in the fluctuation in eruption styles and the mass flux during the eruption, as well as the degassing process which has been reported for many eruptions.