The time sequence of eruption of Baitoushan volcano in 10th century and folktales about the eruption

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The 10th century eruption of Baitoushan (Changbaishan) volcano, situated on the border between China and North Korea, has been one of the largest volcanic eruption over the last 2000 years in the world (Machida et al., 1990). We can detect the ejecta (Baegdusan-Tomakomai ash: B-Tm) from the volcano in northeast Japan more than 1000km far from the source. In many cases, the huge eruption takes the caldera formation after the plinian pyroclastic fall eruption and large pyroclastic flow eruption. We have no actual observations on the huge eruptions, however, the duration of eruption and the relation between plinian fall and following ignimbrite are not known well yet. Thus the study on the time sequence of 10th century eruption of Baitoushan volcano is very important.

Machida et al.(1990) have suggested that the 10th century eruption has ttwo continuous eruptive phases; plinian fall (Baegudu plinian fall: B-pfa) and following pyroclastic flow(Changbai pyroclastic flow :C-pfl) caused by the column collapse of B-pfa eruption , i.e., all episodes were considered to progress continuously without quiescence. Based on the field study in China, we found the possibility of presence of little dormancy between two eruptive episodes. In this study, we give the outline of 10th century eruption, and compare it with the description in the folktales about Baitoushan to evaluate how the folktales are useful to know the past eruption.

Our geological study indicates that the pyroclastic fall deposits are divided into two layers based on the stratigraphy, chemical compositions and the distribution area. Lower part corresponds to B-pfa, that consists of white alkali-rhyolitic pumice. Upper part (C-pfa), is smaller in scale than that of B-pfa, and changes gradually from gray pumice layer to black scoria layer in ascending order. Irrespective of the color difference, all essential materials in C-pfa have the same trachytic compositions. The essential materials in C-pfl are trachytic composition too. C-pfa is overlain directly by C-pfl, partly interbeded. These geological features suggest that C-pfl and C-pfa were due to single episode. B-pfa distributes along southeast direction while C-pfa along north direction. Based on the texture of charcoal in C-pfl Machida and Mitutani (1994) deduced that the season of eruption was winter . Fukuzawa et al. (1998) pointed out that the season of B-Tm were from spring to next spring based on the non-glacial varves. Since B-Tm is composed of both B-pfa and C-pfl, the time interval between two eruptive episodes is estimated to be a half-year. The difference of distributions of each fall deposit may imply the change of wind direction accompanying the seasonal change. It is likely that the C-pfl is not related to B-pfa.

C-pfl consists of many flow-units; the total thickness is more than several ten meters. Only the surface part of this unit changed its color by following oxidation. This implies all flow-units deposited continuously within very short time.

Base-surge deposits, underlain the C-pfl, distribute only inside of the summit caldera. The eruptive style changed from magmatic to phreatmagmatic in the last stage. This suggests that there was a crater lake already at this eruption. Magma to water ratio controls the eruptive style (Wohletz and McQueen, 1984). Therefore this transition may imply that the magma eruption rate decreased in the last stage.

This activity can be divided into three phases. Phase 1: Plinian eruption (B-pfa). Phase 2: Formation of small-scale column and initiation of large pyroclastic flow (C-pfl) after a half-year dormancy. Phase 3: Phreatmagmatic eruption and frequent debris flow due to the reduction of eruption rate. It is also concluded that that phase 1 & 2 finished within a short duration, while, phase 3 continued for several years.