# The 1707 Eruption of Fuji Volcano and Its Tephra

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**Abstract**

The 1707 eruption of Mt. Fuji with large amounts of pyroclastic fall was the most recent and one of the most violent eruptions of this volcano. The magma discharge rate was the largest on the first day and increased again after nine days. No victims of this eruption were reported, except those lost by starvation after the eruption because farmlands had been buried. Further eruptions are possible, so it is important to prepare for them by drafting hazard maps and considering ways to cooperate with Mt. Fuji because the volcano also provides great benefits.

**Key words:** Fuji volcano, historical document, magma discharge rate, tephra, 1707 eruption, volcanic hazard

## 1. The Eruptions of the Fuji Volcano

Mt. Fuji has erupted repeatedly for the last 100,000 years. The mountain is composed of two volcanoes, Older Fuji (100,000 to 11,000 years ago), which erupted on the ancient Komitake volcano (several hundred thousands years old; Tsuya, 1968) and produced basaltic pyroclastics, and Younger Fuji (11,000 years ago to present), which produced basaltic pyroclastics and lava. The 1707 eruption (called the Hoei eruption) was the most recent and most violent eruption of the Younger Fuji volcano. The Younger Fuji built its edifice with many lava flows and pyroclastic deposits (tephra) from its summit and flank craters. The craters of magmatic eruption shifted from the summit to the flanks about 2,200 years ago (Miyaji, 1988). During the 1707 eruption, great volumes of scoria and small amounts of pumice dispersed to the east from the Hoei craters on the southeastern flank of Mt. Fuji (Tsuya, 1955). In this paper, I summarized the sequence and hazards of the 1707 eruption and the characteristics of the tephra from this eruption based on the results of recent studies.

## 2. The Sequence of the 1707 Eruption

The sequence of the 1707 eruption was reconstructed in detail based on many historical documents and geological data (Koyama *et al.*, 2002; Miyaji and Koyama, 2002). On October 28, 1707, a large earthquake (M8.4) occurred on the coast of middle Honshu, the main island of Japan (the Hoei-Tokai-Nankai earthquake). After the eruption, several smaller earthquakes occurred on and around the Fuji volcano.

The eruption started at about 10 a.m., December 16, on the southeastern flank of the volcano with a high column making pumice fall deposits. The tephra changed from pumice to scoria after about six hours from the start of the first eruption. This violent eruption with scoria fall ceased early in the morning of December 17. The eruption continued intermittently until the evening of December 25 with eruptions ceasing for periods of nearly half a day. Violent eruptions occurred again from the evening of December 25 to the 27th. After that, the scale of the eruptions decreased, with rumbling and emission of volcanic bombs on December 31 to January 1. The activity ceased completely on the morning of January 1, 1708. This eruption produced no lava or pyroclastic flows.

During this eruption, three craters were formed, named Hoei First to Third in order of descent from the summit at elevations of 3,100 to 2,150 m. Judging from the distribution of the tephra, the geomorphology of the craters and descriptions in historical documents, the Hoei Second and Third craters were formed on December 16 to 17 or later, and the First crater was formed from December 17 to January 1. Mt. Hoei, which is composed of the tephra of the older Fuji volcano, was formed close to the Hoei craters during the early stages of forming the Hoei First crater.

## 3. Characteristics of the 1707 Tephra

The tephra of the 1707 eruption covers most of the south Kanto plain, including Tokyo, and is found in deep sea cores in the northwestern Pacific Ocean, 280 km distant from the crater (Machida and Arai, 1988). Distribution of the tephra has been reconstructed based on data from historical documents and geological surveys (Fig. 1; Cabinet Office, 2002).

The 1707 tephra is composed of four groups, Ho-I to -IV (Miyaji, 1984). The time of formation of each group was estimated as follows by correlating the description from historical documents with the geological data (Miyaji and Koyama, 2002). Ho-I: coarse pumice layers at the bottom of the 1707 tephra which were formed from the mourning before noon on December 16 to the late afternoon of that day. Ho-II: coarse scoria layers overlaying Ho-I which were formed from the evening of December 16 to the morning of the 17th. Ho-III: an alternation of coarser to finer scoria beds with coarse volcanic ash beds which were formed from the morning of December 17 to the evening of the 25th. The volcanic ash layers of Ho-III may have formed during periods of declining eruptions. Ho-IV: two parts, the lower consisting of coarse scoria beds and the upper of fine scoria beds which were formed from the evening of December 25 to the morning of January 1, 1708.

Magma discharge rates are estimated based on the time of formation and volume of each group. The volume of each group is estimated based on maps of thickness of each group. The total volume is estimated to have been 0.68 $km^3$ of dense rock equivalent which formed over a period of 16 days. The average magma discharge rate during the formation of Ho-I and II was $7\times10^{-3}$ $km^3$/hour, which was the maximum for the 1707 eruption. While the average rate for the Ho-III eruption declined to $1\times10^{-3}$ $km^3$/hour, the rate of the Ho-IV eruption increased to $4\times10^{-3}$ $km^3$/hour, especially during the first half of the period.

The magma composition of the eruption varied from the beginning to the end of the eruption. The pumice of Ho-I changed from dacite to andesite, the scoria of Ho-II was andesite, and the scoria of Ho-III and IV were basalt (Tsukui, 1985).

## 4. Volcanic Hazards of the 1707 Eruption

Many people lost their lives from starvation after the eruption from the eastern foot of Mt. Fuji despite no victims being recorded as a direct result of the tephra fall-out. In the village of Subashiri, at a 10 km distance east of the Hoei craters, 72 houses and three Buddhist temples, which were all part of the village, were burned or crushed on the first day of the eruption. After the eruption, many inhabitants could neither obtain food from their farmland nor move easily to other places, so many died of starvation. The number of houses decreased by one thirds during fourteen years after the eruption in a village where the tephra was two meters thick (Kikuchi, 1990). The Sakawa River, a large river flowing along the eastern foot of Mt. Fuji, flooded repeatedly for nearly 80 years after the eruption. Flooding occurred even on small rivers where the thickness of the tephra exceeded ten centimeters (Cabinet Office, 2002). In these areas,

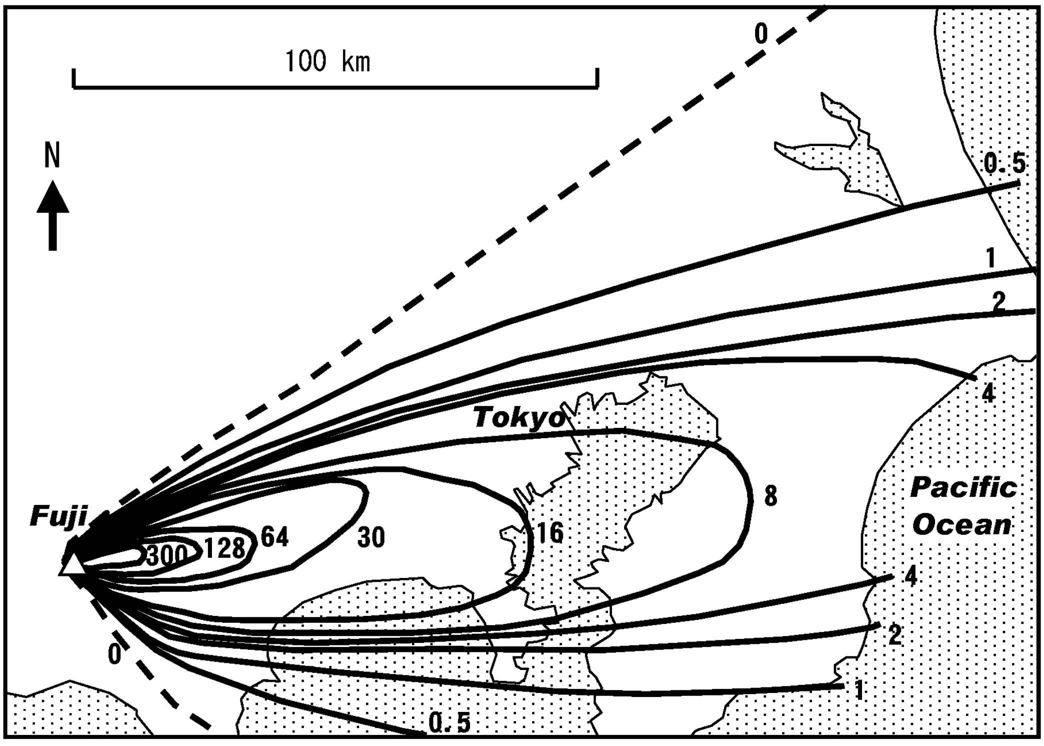


**Fig. 1** Thickness of the 1707 tephra, based on data from historical documents and geological data (in cm). Modified Cabinet Office (2002)

the tephra was probably eroded easily by the rain and deposited thickly on the river bottoms.

## 5. Readiness for the Next Eruption

The increase in low frequency earthquakes in 2000 - 2001 on the Fuji volcano reminds us that the volcano is still active. The Cabinet Office of Japan created a committee in July 2001 to draft a hazard map of the Fuji volcano to minimize hazards during the next eruption. An eruption like the Hoei eruption is the worst-case scenario on the map as the tephra disperses widely in accordance with the wind speed and direction at the time of eruption. We must prepare for this kind of large eruption and also consider that this type of eruption was the largest since 2,200 years ago. Most of the eruptions that occurred during this period were on the order of several tens of times smaller than this eruption (Miyaji, 1992).

At the same time, Mt. Fuji provides us benefits such as a beautiful landscape and flat land areas. The 1707 tephra has been useful as a material for building and gardening. Tephras of the Fuji volcano have become the parent materials for volcanic soil that occupies most of the arable land of the southern Kanto Plain. We must consider the enormous benefits of the Fuji volcano as well as the hazards resulting from the next eruption, and consider ways to cooperate with the volcano.

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(Received 9 September 2002, Accepted 10 October 2002)