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The Inflation-deflation History of Aira Caldera for the Last 120 Years and the Possibility of a Forthcoming Large Eruption at Sakurajima Volcano

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In order to assess the potential for future eruptive activity at Sakurajima volcano, southern Japan, ground deformation around northern Kagoshima Bay (i.e., Aira caldera), especially the height change between leveling stations 2474 and 2480, was re-analyzed. Prior to the large eruption in 1914 at Sakurajima volcano, a remarkable inflation was confirmed at Aira caldera, based on re-surveyed data that were not referred to in previous investigations. Considering those data, the upper limit of the magma storage at Aira caldera just before the 1914 eruption could be obtained. Although the 1914 eruption accompanied a remarkable deflation at Aira caldera, magma started to accumulate again and was likely to have exceeded the level observed in 1900 (14 years before the large eruption). Around the early 1970s, it approached the level before the 1914 eruption. After the ground uplift stopped and slightly reversed during a period of extremely frequent explosions at Sakurajima volcano in the 1970s and 1980s, the inflation seems to again be approaching the inferred level before the 1914 eruption, suggesting the possibility of the next large eruption. In addition, inconsistencies between the inferred amounts of magma supply and observed volumes of erupted materials were discussed and left for further study.

Key words: Sakurajima volcano, Aira caldera, eruption, inflation-deflation, leveling survey

1. Introduction

In January 1914, a large eruption occurred at Sakurajima volcano, located several kilometers from the harbor of Kagoshima City in Kyushu, southern Japan. During this Plinian type eruption, large amounts of volcanic ash and pumice were ejected from the summit crater and thickly covered the surrounding region (*e.g.*, Omori, 1914; Koto, 1916). In addition, lava flowed down to the coast from newly formed small craters on the west and southeast flanks of the volcano. After the occurrence of the eruption, sea water overflowed into the salt fields and the coastal region along the northern part of Kagoshima Bay. According to a subsequent leveling survey by the Land Survey of Japan (1915), a remarkable subsidence of the land was confirmed to have occurred over an area several tens of kilometers in diameter (Fig. 1). It was one of the most remarkable eruptive events in Japan during the last 100 years.

The depressed topography of the northern part of Kagoshima Bay was basically formed as a composite caldera, i.e., Aira caldera (*e.g.*, Aramaki, 1984), which was caused by great eruptions around 29 thousand years before present in calibrated radiocarbon age (*e.g.*, Okuno, 2002). After that, Sakurajima volcano was formed as a post caldera cone at the southern rim of the caldera. As discussed later, it is interesting that Sakurajima volcano was not located at the center of the subsidence accompanying the 1914 eruption of the volcano. Instead, the amount of subsidence at the benchmarks increased towards the center of Aira caldera, and similar movement was also found at triangulation points directed towards the same center (*e.g.*, Land Survey of Japan, 1915; Omori 1916b; Hashimoto and Tada, 1992). The co-eruptive subsidence of the ground strongly suggests that magma had accumulated gradually at Aira caldera, and that it pushed its way to Sakurajima volcano in 1914 (*e.g.*, Omori, 1916b; Sassa, 1956; Mogi, 1957; 1958; Kamo, 1994).

In previous discussions, however, the remarkable evidence of inflation prior to the 1914 eruption (Yamashina, 1997) was not considered. In order to discuss this pre-eruptive deformation and the inflation-deflation process at Aira caldera, the leveling survey data obtained by both the Land Survey of Japan (up to 1946) and the Geographical Survey Institute of Japan (1960 and later; recently named the Geospatial Information Authority of Japan) are reviewed in Section 2.

As indicated in Section 3, the present paper focuses on the height change at leveling station 2474 versus 2480 located 9.5 km north-northeast. Previously, however, the height change has been discussed for station 2474 versus 2469 located 8.5 km southwest (*e.g.*, Sassa, 1956; Kamo, 1994; Eto *et al.*, 1997; Yamamoto *et al.*, 2010). Here,

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