Article

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Vertical Ground Deformation Associated with the Volcanic Activity of Sakurajima Volcano, Japan during 1996−2010 as Revealed by Repeated Precise Leveling Surveys

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The recent vertical ground deformation in Sakurajima volcano and around Aira caldera associated with the volcanic activity of this volcano is revealed by the repeated precise leveling surveys conducted in October-December 2007, November 2009 and April and November 2010. The ground uplifts are detected in Sakurajima volcano and around Aira caldera to be centered in the caldera during the period from 1996 to 2010, as the previous results during the period from 1991 to 1996. From the analysis based on a spherical source (Mogi's) model, the inflation source is located at 8.8 km - 10.8 km depth with the volume change rates of $6.5-8.2\times10^6$ m^3/year beneath the center of Aira caldera generally through the period of 1996−2010. It is indicated that the magma storage at the inflation source inferred at 10 km depth beneath Aira caldera is progressed during the period. In the period of 2007−2009, a shallow inflation source is located at 4.3 km depth with a volume change rate of about 0.6×10^6 m^3/year beneath the northern part of Sakurajima. It suggests the magma movement towards shallow part of Sakurajima volcano from 10 km depth beneath Aira caldera, although the estimated amount of magma input is as small as about 2.0×10^6 m^3.The magma storage at the magma reservoir beneath Aira caldera has continued since around 1991 when the eruptive activity of Sakurajima volcano was gradually decayed. Explosive eruptions are increasing at Showa crater in Sakurajima volcano especially since 2009. However continuing ground uplifts are observed until November 2010. It is suggested that the amount of supplied magma overcomes that of ejected magma at the magma supply system beneath Aira caldera in spite of the increasing volcanic activity. Considering the estimated volume increase at the inflation sources and the volume of the ejected magma based on the observed amount of the ash-fall deposits, it is indicated that the total of about 1.2×10^8 m^3 magma is inferred to have additionally stored beneath Aira caldera during the period from 1991 to 2010. The ground uplift around the northern part of Sakurajima caused by the progressing magma storage at the time of November 2010 recovers and further exceeds the height level in around 1973, when the intense summit eruptions during the 1970s and the 1980s started. These results suggest the immanent potential of the next intensive eruptive activity of this volcano.
Key words: Sakurajima volcano, Aira caldera, precise leveling survey, vertical ground deformation

1. Introduction

Sakurajima volcano is an andesitic stratovolcano located in southern Kyushu, Japan (Fig. 1). It is situated on the southern rim of Aira caldera. At this volcano, the flank eruptions with the lava flows and the summit eruptions have been repeated during historic times, including the great eruption in 1914. The current eruptive activity at the summit crater of Minamidake began in 1955, which is characterized by violent explosive eruptions of a Vulcanian type, as well as the intermittent emissions of volcanic ash. In addition, the eruptive activity at Showa crater on the eastern slope of the volcano started in June 2006 and the activity has increased in recent years. The total number of explosive eruptions since 1955 exceeds 9500 in 2010.

Repeated precise leveling surveys have been conducted in and around Sakurajima volcano since 1957 (Eto, 1967; Eto *et al.*, 1997; Yoshikawa, 1961). The results suggested that the ground deformation associated with the eruptive

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