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An Interpretation on Secular Changes in Deformation Caused by the 1914 Eruption of Sakurajima Volcano

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The 1914 eruption of Sakurajima volcano was one of the largest ones in its history and first observed with scientific methods of those days. The eruption flowed out a large volume of lavas, and was accompanied with remarkable deformations on and around Aira caldera. The deformations consist of three stages: pre-eruptive, co-eruptive and post-eruptive ones: The first one is determined by temporal tide-gauge observations at Kagoshima Port but, its origin is still unsettled. The second one is a quasi instant and elastic deformation, and therefore interpretable by a simple model. However, the location of center of depression is ambiguous due to the insufficient number of observations. Prior to the interpretation, it is re-examined considering the results of triangulations in the wider area, and the location changed about 5 km S, on Sakurajima Island. The revised location of depression center can well interpret the observed depression and compromises with seismological and petrological knowledge. The last one is a secular recovery stage, and it has remained highly problematic whether its origin is endogenous or exogenous. The present author interprets that the recovery changes are composed of two factors: In the period before around 1940, viscoelasticity of the crust acted predominantly (endogenous) and later magma pressure accumulated in the reservoir gradually joined to act (exogenous) and its contribution had become noticeable after 1955. The recovery of the depression is interpreted as viscoelastic with retardation time of 16.6 years. Hence, viscosity of the earth crust around Aira caldera is determined at about 3×10^{19} Pa·s on the assumption that the crust is Kelvin-type. The value is comparable to those obtained with Miyake volcano and by laboratory measurement of a granite piece.

The other cases of viscoelastic deformations accompanied with volcanic eruptions are searched: the 1779 eruption of Sakurajima volcano and the 1983 eruption of Miyake volcano are exemplified.

Key words: Sakurajima volcano, volcanogenetic deformation, recovery of deformation, viscoelasticity of the crust

1. Introduction

Sakurajima volcano stands on the S rim of Aira caldera measuring about 20 km in diameter. The historical records of eruptions on Sakurajima date back to 708 A.D. In its eruption history, the 1471～76, the 1779～80 and the 1914 eruptions are the largest threes, all discharging considerable amounts of lavas from parasitic craters. At present, the volcano is one of the most active volcanoes in the world.

The 1914 eruption was fully described and studied geophysically by Omori (1914−1922) and geologically by Kotô (1916). The present discussion owes very much to their works though it is limited to a study on deformations caused by the eruption. The significant subsidence around Aira caldera caused by the 1914 eruption were confirmed by repeated precise levelings and triangulations by the Military Survey as shown in Figs. 1 and 4 where the location of center of the subsidence is inevitably ambiguous because the observations were limited on land and their number was not enough. The secular recovery of the 1914 subsidence has been pursued for about one century after the eruption. During the period, the 1946 eruption issued lava flows and the recovery was partly reversed. After that, the recovery has proceeded further and attained the original level around 1970.

Such remarkable crustal deformations and their secular changes have held the earth-scientist's interest and roused many arguments. Firstly Sassa (1956) mentioned possible relationship between the secular recovery of the 1914 subsidence and the activities of Sakurajima volcano. And Mogi (1958) discussed the deformation and achieved to interpret it by a source of dilatational type. Later Yokoyama (1986) studied the secular changes on the data of those days, and further, extended his idea to a discussion of caldera structure in general (Yokoyama, 2005).

2. Deformation Related to the 1914 Eruption of Sakurajima Volcano

Networks of precise levels along the route circulating Aira caldera were first established in 1892 by the Military

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