

2001年箱根群発地震活動に伴った傾斜変動と圧力源の時間変化

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Temporal Change of the Pressure Source Estimated by Tilt Records
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Remarkable changes were observed by tiltmeters installed in the Hakone caldera during the 2001 intense swarm activity. Using the records of the tiltmeters as well as the GPS data acquired by the Geographical Survey Institute (GSI), we investigate the pressure source which produced the crustal deformation. We divide the period from May 23 to September 9 into five stages based on the changes in the direction and the rate of tilt at Komagatake Station. The overall model during the whole period is composed of a Mogi-source at a depth of 7 km (volumetric expansion: $7.1 \times 10^6 \text{ m}^3$) and two shallow open cracks (depth range 0–0.2 km; volumetric expansion $0.15\text{--}0.51 \times 10^6 \text{ m}^3$). The tilt changes in each stage, including that in the first stage at the time when the swarm activity had not yet commenced, is well explained by the expansion of the same cracks, which is considered to show the validity of our pressure models. The strike of the crack in owakidani and that near Komagatake are WNW-ESE and NW-SE, respectively. The S-wave splitting analysis (Honda and Tanada, 2006) indicates existence of cracks in those directions around the source region, and many fissures in the NW-SE direction are observed on the surface of the field (Kobayashi *et al.*, 2006). However, local earthquakes are not distributed along the direction, but the epicentral area extends from south to north as a whole. This feature differs from that of the swarm activity occurring in the region east-off Izu Peninsula, in which extension of hypocentral distribution is estimated to correspond to the zone of dike intrusion. We consider that up-rising steam or volcanic gases compelled to open the pre-existing cracks to produce the crustal deformation in the 2001 Hakone swarm activity. It is plausible that the two-crack pressure source of our model represents a set of many small cracks or the largest one in the source region.

Key words: Hakone volcano, earthquake swarm, crustal deformation, temporal change, tiltmeter

1. はじめに

箱根火山は本州中部の伊豆半島北端部に位置する活火山である。有史のマグマ噴火の記録はないが、多数の有感地震を伴う火山性の群発地震活動がこれまで何度か観測されている。平賀 (1987) によれば、1786年以降約130年間の平穏期を経て、1917年、1920年、1935年、1943年、1952年、1959年に有感地震や地鳴りを伴う規模の大き

な群発地震が発生し、中には噴気異常が認められた活動もあった。1960年以降は小規模な地震活動はあったものの、地鳴りや噴気異常を伴うような群発地震は2001年まで発生していなかった (平賀, 1987; 伊東・棚田, 1999; 萬年, 2003)。2001年の群発地震活動は、約4ヶ月に及ぶ発生期間の長さや地震の体感回数多さ、噴気異常の出現などの点から見て、平賀 (1987) がまとめた過去の顕

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