論　説

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2004–2005年浅間山火山活動に伴う地殻変動

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Ground Deformation Associated with the 2004–2005 Unrest of Asama Volcano, Japan

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Ground deformation associated with the most recent eruptions in Asama volcano started on September 1, 2004, is reported. The ground deformation observed by continuous Global Positioning System measurements is modeled by dike intrusion for two different periods; one is between July, 2004, to March, 2005, which represents overall deformation during the unrest, and the other is between November, 2004, to March, 2005, which represents the deformation during the latter half of the unrest. We assumed a rectangular dike opening uniformly in elastic, homogeneous, and isotropic medium to model the deformation field. To solve a nonlinear optimization problem in which model parameters are nonlinear to observed deformation field, the Simulated Annealing inversion was employed. The uncertainties of and trade-offs between the model parameters are estimated by the Bootstrap method.

The results show that the deformation field is well modeled by a dike striking roughly east-west, strike of which is consistent with the regional stress field. Shape of the dike, that is, length, width, and thickness, is not well constrained due to the small amount of deformation, up to 10 mm, and the scarcity of GPS sites, but volume of the dike is well constrained to be 6.82 and 4.63 million cubic meters for the whole period and the latter half, respectively. The estimated depth of the dike tip is roughly 1 km below the sea level; the depth of hypocenters is consistent with a theory of dike-induced earthquakes that they occur near the dike tip due to the stress concentration. However, the comparison of the location of the modeled dike and the distribution of earthquakes clearly shows that the hypocenter distribution is inconsistent with the theory described above, that is, the hypocenters are distributed only in the eastern half of the modeled dike tip. The possible reasons for this inconsistency are either 1) earthquakes exists in the west half of the dike tip as well, but they are not detected due to the sparse distribution of seismometers at the west of the flank, 2) the western half of the modeled dike is not capable of generating earthquakes because the temperature is too high for brittle failure of rocks, or 3) the differential stress in the western half is so low that the area cannot reach the critical stress field even by the introduction of dike-tip stress concentration. Current geophysical observations cannot identify the reason but future development of geophysical observations is expected to solve the puzzle.

Key words: ground deformation, Asama volcano, dike intrusion, Global Positioning System, geodetic inversion

1. はじめに

浅間火山は長野・群馬県境に位置し，太平洋プレートの東からの沈み込みにともなう島弧火山の一つである (Fig. 1a)．浅間火山では有史以来1108年と1783年に大規模噴火をし，20世紀に入り1960年代まではブルカノ式噴火を繰り返していたが，その後1973，1982，1983年の中規模噴火活動を除いて活動は低下した．近年噴火活動は低下していたのにも関わらず山頂直下においてマグマの何らかの動きを反映すると思われる火山性地震が観測されていた（例えばSawada, 1994; Fujita and Ida, 1999; Aoyama and Takeo, 2001）．

浅間火山においては地震活動だけでなく，マグマの何

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