

Very Long Period Seismic Signals Observed at Iwojima Volcano

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1. Introduction

Iwojima Island, located about 1250 km to the south of Tokyo, Japan, is a volcanic island where a geothermal activity and crustal deformation are very active. The island, measuring 8km in length and 4 km across, has a dome-like mountain Motoyama at the earthen part of the island and a volcanic cone Suribachi at the southwestern edge of the island. Motoyama is a post caldera dome which uplifted more than 100m during the last several hundred years. Motoyama had continued to subside since 2003, but it began to uplift at August 2006. GPS data show Motoyama uplifted about 40 cm during the period from August 2006 to January 2007. Number of earthquakes began to increase at late November 2006, and exceeded 100 times in a day at the end of 2006. The earthquakes include some very long period earthquakes (VLP earthquake). We report the VLP earthquakes observed at Iwojima.

2. Observation

NIED conducts continuous observations with short-period seismometers at three stations (2 stations at Motoyama and one station at Suribachi) and a broad-band seismometer (STS-2) at the station of Suribachi. In this study, we also use short-period seismometer data and tiltmeter data installed by Ministry of Defense at the earthen part of the island.

3. Characteristics of the VLP earthquakes

The VLP earthquakes are clearly observed by the seismometers and tiltmeter. The earthquakes have a damped oscillation wave form and last about 10 minutes. Power spectrums of the VLP earthquakes show that they have not less than three predominant periods between 12s and 29s, but the predominant periods are not multiple numbers. The VLP earthquakes have short-period components with magnitude of 1.4~3.3 at the initial part of the earthquakes.

The search of the past data after 1995 for VLP earthquake show that the VLP earthquakes mainly occurred during the period from late 2000 to the beginning of 2003 and after September 2006. During the former period, Motoyama also uplifted more than 1m. The periods when the VLP earthquakes occur correspond with the period of the uplift. We count VLP earthquakes before 2002 in the paper records of short-period seismometers.

Based on the similarity of wave form of VLP earthquakes, we can divide 13 VLP earthquakes among 14 VLP earthquakes after 2003 into two groups. These hypocenters of earthquakes of each group are probably close to each other and earthquake mechanisms are similar. The epicenters determined by the short-period initial phase of two groups are located at the western part of the island and Motoyama, respectively. The depths of the hypocenters are shallower than 2km as well as other high-frequency earthquakes in Iwojima.

The very long period oscillations of the VLP earthquakes have biased direction: vertical directions at three stations at Motoyama and north-east and downward direction at the station of Suribachi. Assuming the VLP oscillations are compressional waves, we speculate that the hypocenters are located beneath the center of Motoyama (the center of caldera) 4~6km deep, where is deeper than the hypocenters of the short-period initial phase.

4. Summary

In Iwojima, the VLP earthquakes sometimes occur during the period of the large uplift of Motoyama. The earthquakes last about 10 minutes, and have damped oscillation wave forms and not less than predominant periods between 12s and 29s. The VLP earthquakes have short-period seismic signals at the initial part of the earthquakes. The oscillations of VLP seismic signals at the stations have biased direction. Assuming the VLP signals are compressional waves, we speculate that the hypocenters are located beneath the center of Motoyama (the center of caldera of Iwojima) 4~6km deep.

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