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Source Mechanisms of Harmonic Tremors at Sakurajima Volcano

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Source mechanisms of harmonic tremors observed after B-type earthquake swarm (HTB) and those immediately after explosive eruption (HTE) at Sakurajima are estimated by inversion of root mean square (RMS) seismic amplitudes of 3 components at 5 stations. HTB and HTE had a similar source mechanism that indicates isotropic components of more than 50%. Source depths of the HTB and HTE correspond to the location of a gas pocket formed at uppermost part of the conduit. We infer that HTB is generated by resonance of the gas pocket formed after swarm of B-type earthquake and that HTE is related with resonance of the gas pocket of which top is partially collapsed by the explosion.

Key words: harmonic tremor, moment tensor, Sakurajima volcano

1. Introduction

Eruptive activity with Vulcanian style has continued at the summit crater, Minamidake of Sakurajima since 1955. Harmonic tremor (C-type tremor) have been observed in active eruptive stages at Sakurajima volcano (Kamo *et al.,* 1977; Nishi, 1984), and are characterized by regular peaks of spectra, composed of fundamental frequency and its overtones from analyses of spectrum and particle motion (e.g. Kakuta and Idegami, 1970; Kamo *et al.,* 1977). As a result, the harmonic tremors are classified into two types. One is the tremors observed several hours after B-type earthquake swarm (HTB) and the other is the tremors observed a few minutes after explosive eruption (HTE). Peak frequencies of HTB are constant in duration of vibration. In contrast, those of HTE gradually increase (Maryanto *et al.,* 2005). During 1982–2002, 993 HTBs occurred and only 5 HTEs were recorded. HTEs were rare harmonic tremor at Sakurajima volcano.

Mechanisms of harmonic tremors have been investigated by analyses of spectra at other volcanoes. Harmonic tremor at Semeru volcano was caused by repetitive triggering sources at shallow part (Schlindwein *et al.,* 1995). Hellweg (2000) proposed that harmonic tremor at Lascar volcano was excited by movement of water and gases near the surface. These studies discussed mechanisms on regular repetition of triggering source for harmonic tremors; however source mechanism of the trigger source has not been investigated. Radiation pattern or moment tensor of the harmonic tremors were also practically not reported. And also, their source locations were inferred at shallow parts near the surface, but the depths were not quantitatively determined in the previous studies. Maryanto *et al.* (2005) indicated that Rayleigh waves were dominant in harmonic tremors at Sakurajima volcano from analyses of particle motion.

In this study, we estimate moment tensor and source depths of the two kinds of harmonic tremors, HTB and HTE, at Sakurajima volcano from spatial distributions of RMS seismic amplitudes. We further discuss common and different factors in their source mechanisms.

2. Data

Seismograms at 5 stations ranging 1.7–4.4 km from the active crater (Fig. 1) are used for analyses. At 4 stations, three-component short-period seismometers (natural period $T_0 = 1$ s, damping constant $h = 1.0$) are installed in boreholes at depths of 85 to 290 m. Station HIK is equipped with the seismometers installed on the surface in vaults. One horizontal component seismometer is set parallel to the direction from the station to the summit crater (longitudinal component) and the other is set perpendicular to the direction (tangential component). Velocity seismograms recorded before 2001 were digitized with an A/D resolution of 12 bit and a sampling rate of 200 Hz from analog magnetic tapes. Seismic signals recorded after 2001 were recoded with an A/D resolution of 22 bit and a sampling rate of 200 Hz.

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桜島火山におけるハーモニック微動の震源メカニズム

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桜島火山において発生するハーモニック微動のモーメントテンソル解析を行った．B 型地震群発後に発生する微動（HTB）と爆発的噴火直後に発生する微動（HTE）のモーメントテンソル成分に大きな違いはなく，等方成分は 50% 以上，CLVD 成分は 20〜30%，DC 成分は 20% 以下であった．鉛直方向のダイポール成分が大きく，鉛直方向の力が優勢な震源が推定される．震源は火口直下の浅部であり，爆発的噴火発生前に火口底直下に形成されているガス溜まりが微動の発生に関与していると考えられる．