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Semi-Volcanic Deep Low-Frequency Earthquakes

ASO, Naofumi[1*], OHTA, Kazuaki[1], KURIHARA, Yoshiharu[1], IDE, Satoshi[1]

[1]The University of Tokyo

<Backgrounds>

Deep low-frequency earthquakes (LFEs) are categorized into three types based on their locations: volcanic LFEs near the Mohorovicic discontinuities beneath active volcanoes, tectonic LFEs on the plate boundaries, and isolated intraplate LFEs near the island arc Mohorovicic discontinuities far from active volcanoes. The geographical distribution of LFEs suggests that these three types of LFEs are related to great natural phenomena such as volcanic eruptions, interplate megathrust earthquakes, and large inland earthquakes, respectively. While tectonic LFEs have been revealed in many respects since their discovery in the beginning of this century, volcanic LFEs and isolated intraplate LFEs are less understood and the previous works on them tended to focus on individual activities of regional LFEs [e.g., *Hasegawa et al.*, 1991; *Ohmi and Obara*, 2002]. As a comparative study, *Aso et al.* [2011] pointed out that the isolated intraplate LFEs in Osaka Bay show similar activities to volcanic LFEs, but the universal characteristics of LFEs and the basic differences between three types of LFEs have never been revealed. In the present study, we extracted the common characteristics of isolated intraplate LFEs by analyzing the activities of isolated intraplate LFEs in multiple regions, and compared three types of LFEs based on a common method by analyzing volcanic LFEs and tectonic LFEs in the same way.

<Data and methods>

Based on the method developed by *Aso et al.* [2011], we analyzed and compared the seismicity of isolated intraplate LFEs in Osaka Bay and eastern Shimane, volcanic LFEs in Sakurajima, and tectonic LFEs in northern Kochi and central Ehime. Because the detected LFEs by Japan Meteorological Agency (JMA) are not sufficient for statistical analysis, in the present study, we automatically detected LFEs using waveform correlation on the Hi-net continuous records and estimated the magnitude of the detected LFEs based on the amplitude ratios. To study temporal and spatial characteristics, we quantified the sensitivity to tidal stress by taking activity spectrum and examined the detailed structure of hypocenter distribution by applying the NCC relocation method [*Ohta et al.*, 2008].

<Result and discussions>

The isolated intraplate LFEs and volcanic LFEs obey the Gutenberg-Richter law with a b-value of 2, while distinct upper limits were found in the frequency magnitude statistics of tectonic LFEs. The activity spectra of the isolated intraplate LFEs and volcanic LFEs show no evidence of tidal modulation, while those of tectonic LFEs have a clear peak at the M_2 period, suggesting tidal modulation. The relocated hypocenters of isolated intraplate LFEs and volcanic LFEs are distributed vertically as well as horizontally, while the distributions of tectonic LFEs are linear or planar on the nearly-horizontal plate boundary. These characteristics of three types of LFEs in five regions manifest that isolated intraplate LFEs are quite similar to volcanic LFEs, and that tectonic LFEs are different phenomena. Moreover, the discretized triggering model developed by *Kurihara et al.* [2012 (this meeting)] shows similar triggering probabilities for isolated intraplate LFEs and volcanic LFEs. In addition to the fact that most isolated intraplate LFEs occur beneath Quaternary volcanoes, these new findings about activities of LFEs suggest that isolated intraplate LFEs are generated by movements of fluids, as suggested for volcanic LFEs previously. Hence we propose that isolated intraplate LFEs should be named as ”semi-volcanic” LFEs. In the future works on LFEs, semi-volcanic LFEs should be regarded as almost the same phenomena to volcanic LFEs, and their analyses may contribute to the understanding of volcanic LFEs and volcanism. Another kind of important information to identify the actual physical process is provided by focal mechanisms, which have been also estimated reliably by *Aso et al.* [2012 (this meeting)].

Keywords: Low-Frequency Earthquake, Semi-Volcanic LFE