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Volcanic-like Deep Low-Frequency Earthquakes beneath Osaka Bay

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Among the many deep low-frequency earthquakes (LFEs) recently discovered worldwide, LFEs beneath Osaka Bay, western Japan, are especially unusual. Their waveforms are monochromatic, resembling those of some volcanic LFEs, but there are no volcanoes around. The area is close to but clearly distinct from a belt of tectonic LFEs, and is near the site of a large inland earthquake (the 1995 Kobe earthquake).

To characterize the activity of these LFEs, we present an extensive catalog constructed using a matched filter analysis on continuous seismic records with template LFEs determined by the Japan Meteorological Agency.

The relocated catalog of 1221 events over a period of 5 years shows spatially concentrated activity in two volumetric zones, with several active periods including successive tremor-like events. The magnitude-frequency statistics satisfy the Gutenberg-Richter law with a b-value of 2. Unlike tectonic LFEs, which are highly sensitive to tidal stress, the LFEs beneath Osaka Bay show no spectral peak in activity at tidal periods, and the overall pattern of the spectrum is similar to that of volcanic LFEs beneath Sakurajima, Japan.

These findings suggest that the Osaka Bay LFEs are almost same as volcanic LFEs in origin, or at least related to fluid upwelling from the mantle.

Keywords: Low-frequency earthquake, Osaka Bay, Japan, Volcanic earthquake, Matched filter, Tidal modulation, G-R law