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Moment tensor inversion of broad-band ocean bottom records from very-low-frequency earthquakes off Kii peninsula (2)

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We installed three broadband ocean bottom seismometers (BBOBSs) from July 2008 to October 2009 off Kii peninsula, Japan (Sugioka et al., in preparation): in the study area activities of the very low frequency (VLF) earthquakes have been reported (Ishihara, 2003; Obara and Ito, 2005). Our BBOBSs successfully recorded VLF swarms re-activated after five years of quiescence at very short epicentral distances. During the last SSJ Fall meeting (2010) we reported the preliminary results of the waveform inversions of the VLF events. Here we report the updated moment tensors, source time functions, and waveform-relocated source positions determined by using a new structural model.

We compute the synthetic waveforms by a 2.5D finite difference method (Okamoto, 2002) because the BBOBSs were installed on the ocean bottom that is an irregular solid-fluid interface, and because the data were recorded very close to the VLF sources: approximations with flat-layered structure or with far-field terms should be avoided. In this report, we assume a "new" crustal model based on the results of detailed seismic experiments performed in the source area: we incorporate oceanic layer, sedimentary layers, and subducting oceanic crust in the new model. Assuming a point source for the VLF source, we infer the moment tensor and the source time function simultaneously by using a non-linear waveform inversion method (Okamoto and Takenaka, 2009). Finally we apply the waveform-relocation procedure (Okamoto, 1994; Okamoto and Takenaka, 2009) to determine the best point source position: in the procedure we setup a three-dimensional grid of candidate source positions, and apply a grid search to find the best source position that minimize the residual between the observed and synthetic waveforms. The data used for the inversion are the waveforms of three components of ground velocity with durations of 120-150 s from the onset. We apply a band-pass filter (8-50s) to the raw data. For some data we also generated waveforms by applying another band-pass filter with very long period (50-360s).

We analysed eleven VLF events whose moment magnitudes were about four. We found that most (nine) of the events had shallow angle thrusting mechanism. The estimated depths of the nine events were in the range between 6.4 km to 8.4 km. Moreover, five events had very shallow, near horizontal nodal plane (i.e., dip angles were less than 10 degrees). These results strongly suggest that the shallow angle thrusting events represent the slips along the very shallow part of the plate boundary under the accretionary prism. The estimated durations of the source time functions (30-50 s or longer) of the VLF earthquakes are much longer than the typical values for M4 events.

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Keywords: VLF earthquake, Off Kii Peninsula, moment tensor, crustal deformation, finite-difference method