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The 25 March 1998 Antarctic earthquake: Source process and moment tensor obtained from long-period surface waves

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Study of the teleseismic P and SH waves showed that the source process of the Antarctic earthquake has two clusters of strike-slip subevent. Our spectral analysis using long-period surface waves suggests that the second cluster is located 170km from the hypocenter toward the N250E. The distance is larger than that in the body-wave analysis (120km), but smaller than the length of the aftershock area (about 300km). Moment tensor solutions obtained using the surface waves in this study have the T axes in the NW-SE direction, and are characterized by significant non-double-couple components (NDCC). Our numerical experiments suggest that the NDCC cannot be explained by the source models consisting of the two clusters of strike-slips alone. We thus need other origins for the NDCC.

We examine the source process and moment tensor of the Antarctic earthquake with long-period surface waves recorded by the networks of IRIS and GEOSCOPE, focusing on the ruptured length and the non-double-couple component (NDCC) in the moment tensor.

Study of the teleseismic P and SH waves shows multiple nature of the source process having two significant clusters of nearly pure strike-slip subevents (Kikuchi et al., 1999). In the body-wave source model the second cluster is located 120km west of the epicenter, and the distance is much shorter than the length of the aftershock area (275km, Wiens et al., 1998; 300km, Nettles et al. 1998). Kikuchi et al. (1999) point out that the location of the second cluster is uncertain, depending on assumed depth of the cluster (Kikuchi et al., 1999). In this study, we examine the location of the second cluster or the whole fault length, independently using long-period surface waves. The method follows Zhang and Kanamori (1988) and Zhang (1998). We use fundamental-mode spectra of Rayleigh and Love waves (R1, R2, G1, and G2). When we assume that the source process consists of two events, following the body-wave analysis, the location of the second event is estimated to be 170km from the hypocenter toward the direction of N250E. The moment ratio is 1:0.5. The rupture propagation velocity ranges from 2.2 to 2.8km/s. When we assume that rupture unilaterally propagates with uniform slip, without considering the result from the body-wave analysis, the fault length is 190km and the rupture direction is N250E. These estimates of the ruptured length are larger than that in the body-wave analysis, but still smaller than the length of the aftershock area.

Moment tensor solutions obtained in this study by the CMT inversion and spectral inversion of Zhang and Kanamori are similar to one another, which have the T axes in the NW-SE direction and are characterized by significant NDCCs in a sense that the tensional principal strain is predominant. The solutions are in good agreement with the Harvard CMT solution. The significant NDCC is thus observed, irrespective of choice of the method and dataset. A possibility is that the NDCC is apparently caused by the multiple nature of the source process. We test the possibility by numerical experiments. We first compute synthetic waveforms with a source model derived from the body-wave analysis, and invert the synthetic waveforms as data, cheking the size of the NDCC in obtained moment tensor. We test two source models. One is the final source model of the body-wave analysis, which consists of the double-couple subevents. The other is the shallow source model, for which the clusters are set to be shallow, consisting of subevent moment tensors with slight NDCCs. However, for either source model, a significant NDCC cannot be observed in the experiments, either for the CMT method and spectral inversion. The body-wave source models consisting of two subevent clusters alone are not able to explain the significant NDCC. We thus need other origins for the NDCC, for example, additional seismic energy release neglected in the studied source models, effect of heterogeneous structure not included in the used Earth model.