Complex Source Process of the 2018 Gulf of Alaska Earthquake Revealed by Flexible Finite-Fault Inversion of Teleseismic Waveform

*Shinji Yamashita[1], Yuji Yagi[1], Ryo Okuwaki[1], Kousuke Shimizu[1]

1. University of Tsukuba

On 23 January 2018, a magnitude 7.9 earthquake ruptured in the shallow part of the Pacific plate offshore Kodiak Island. The Global Centroid Moment Tensor solution showed a strike-slip faulting with large non-double-couple components, and the teleseismic *P* wave backprojection indicated geometrically complex source evolution. Although several finite-fault models of the Alaska earthquake have been proposed so far, the assumption of fault geometry differs from each other, which makes it difficult to derive unified interpretation of fault geometry and source process of the 2018 Alaska earthquake. Here, we adopted a flexible finite-fault inversion that no longer requires assumption of fault geometry and estimated both spatiotemporal slip-rate distribution and focal mechanisms along an assumed model plane. In the inversion formulas, the smoothness constraints were applied to the slip-rate distribution with time and space to perform stable inversion. However, in the conventional smoothness constraints, each slip components were improperly smoothed because the spatiotemporal distributions of slip rate functions introduced the same covariance Gaussian into all slip components. In this study, we propose a new smoothing formulation; that is, the smoothness strength of each slip component is in inverse proportional to its contributions to an independently inferred moment tensor solution. Instead of arranging a square model plane, we placed the model plane horizontally according to aftershock distribution to prevent the large discrepancy of the possible source area. The moment rate function obtained by our analysis represents two main peaks until 20 s from the hypocentral time and eight minor peaks from 20 to 65 s. The spatial slip distribution shows predominant strike-slip faulting and the large slip appears around 40 km north area from the epicenter. The rupture evolution can be divided into two stages; the first stage (0 to 20 s) is spatiotemporally continuous rupture propagation around the epicenter, and the second stage (20 to 65 s) was multiple shocks corresponding to the eight peaks in the moment rate function. The initial rupture propagated mainly northward from the epicenter with a strike-slip mechanism until 10 s from the hypocentral time with clockwise rotation of strike angles about 10° during the propagation. Then, this northward rupture transferred to ~50 km northeast region from the epicenter during 8 to 16 s with the N-S and E-W trend strike directions of focal mechanisms. After that, the rupture propagated to ~40 km west region of the epicenter during 10 to 20 s. The westward rupture was predominated by strike-slip mechanisms. After 20 s, the eight subevents occurred intermittently every few seconds which cannot be identified by the conventional smoothness formulas due to the excess smoothing for strike-slip components and the subevents occurred from 40 to 80 km of the epicenter which was near the edges of the large ruptured in the first stage during 0 to 20 s. The calculated waveforms reproduced sufficiently observed complex waveforms, indicating that the details of the rupture evolution are captured well.

