Expansion of aftershock area caused by propagation of postseismic sliding: A numerical simulation

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It is known that the aftershock areas of large earthquakes often expand with time (Tajima and Kanamori, 1985). This suggests that the stress increase due to coseismic slip gradually propagates outward from the main shock rupture area. It is probable that this propagation of stress increase is caused by the propagation of postseismic sliding, which has been detected for many large earthquakes by geodetic observations mainly with Global Positioning System (GPS) (e.g., Ozawa et al., 2004). Propagation of postseismic sliding has been estimated also from analyses of small repeating earthquakes at the Sanriku subduction zone (Uchida et al., 2004). In the present study, I perform a numerical simulation on the expansion of aftershock area caused by the propagation of postseismic sliding.

The model fault in an infinite elastic medium is loaded at a constant displacement rate, and the frictional stress on the fault obeys a laboratory-derived rate- and state-dependent friction law (Kato, 2004). Nonuniformity in frictional constitutive parameters is introduced on the model fault plane so that a large asperity for a large earthquake and many possible nuclei of aftershocks around the asperity may be distributed. Velocity-weakeing frictional property is assumed at the asperities, and velocity-strengthening friction is assumed for the other area. The simulation can reproduce aftershocks triggered by stress increase due to postseismic sliding and the expansion of aftershock area. The propagation speed of the aftershock-area expansion decreases with an increase in A-B, which expresses the rate dependence of steady-state friction stress. The simulated aftershock area at 7 days and 30 days from the main shock are approximately 30% and 50%, respectively, larger that that of 1 day aftershock area. This roughly agrees with the observed result for large dip-slip earthquakes by Henry and Das (2001). The expansion of aftershock area ceases within 1 year from the main shock in many cases.

References

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