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A consideration about computation of tectonic stress field for inland thrust earthquake

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In the case of pure thrust earthquake, the driving stress system is expected to have been as shown in Fig.1a. The stress in this figure is tectonic stress; thus, the lithostatic pressure σ_V(=ρgh) must be added. The tectonic system (Fig. 1a) can be decomposed into two systems (Fig. 1b): A and B. The functional forms of σ_X and σ_Y are unknown. The assumption that that σ_X is uniform in system A causes almost uniform shear and normal stresses on the fault. Strength (peak stress) and dynamic friction can be estimated when σ_V (=ρgz) is added to the fault normal stress and the resultant normal stress is multiplied by static and dynamic frictional coefficients. Under these conditions, we found a large stress drop in the shallower parts and minimum strength excess at the free surface. This suggests that the earthquake rupture must have started at the surface and that the stress drop must have been the highest at the ground surface. These results can be avoided if the stress σ_X is assumed to increase with depth. The depth dependency is related to variations in elastic constants. The stress field in this region likely originated primarily from plate motions. Therefore, we selected the displacement boundary condition u_X=u_0, which correspondings to system A' in Fig. 1c. It should be noted that other displacement components were not fixed, but free stress conditions (except the σ_{xx} component) were imposed according. After solving the stress field imposing the above boundary condition, the resultant stress component σ_{xx} was added on the boundary of x=$\pm$$L_X$ as a further boundary condition. The solution is the same as the problem in which the boundary condition is imposed. Taking the linear elasticity into account, the target solution can be estimated by superposing solutions A and B in Fig. 1b. System A is equivalent to system A'. The effect of system B on fault normal and shear stress is expected to be negligible, because these stresses are exactly zero for a uniform structure. We estimated such effects in a heterogeneous structure by assuming that the value of σ_Y=σ_{yy} (z) on the boundary of y=$\pm$$L_y$ is the same as σ_{xx} (z) on the boundary of x=$\pm\pm$$L_x$. We found system B to exert little effect (less than 5%) on the stress components of σ_{zx}, σ_{xx}, and σ_{zz}. Thus, B had little effect on fault normal and shear stress on the fault plane, where σ_{xx} (z) is the averaged stress component along the y-axis on the corresponding boundaries. Based on the condition of thrust earthquake that $||\sigma_X|>|\sigma_Y|>|\sigma_Z|$(Fig. 1a), the above mentioned σ_{zx}, σ_{xx}, and σ_{zz} were overestimated in our study. Thus, we can ignore the effects of system B.

Keywords: inland earthquake, stress field