

Development of a method to estimate spatial stress pattern from P-wave first motion data: a preliminary numerical simulation

*Takaki Iwata¹

1.Tokiwa University

A method of estimating spatial stress pattern from a centroid moment tensor (CMT) dataset has been developed by Terakawa and Matsu'ura [2008, GJI, 172, 674-685]. However, often the number of available CMT solutions is limited if our interest is the estimation for a small area. For such a case, it is difficult to apply this method because of the insufficiency of data. To meet this difficulty, this study proposes a method to estimate from P-wave first motion data, instead of CMT data. We assume that the direction of a pre-existing fault plane is random and that the direction of a seismic slip is parallel to that of the tangential component of the stress vector. Under these assumptions, we can compute the probability of the polarity (up/down) of a P-wave first motion if stress field at an hypocenter and the geometry between the hypocenter and seismic stations are given. Thus, on the basis of a likelihood function constructed from the computed probability and a prior distribution corresponding to a spatial smoothness constraint on the stress field, we can estimate the spatial stress pattern through a Bayesian approach.

The development of this method is currently at preliminary stage, and thus only a numerical simulation has been done. For the simplicity of the simulation, a case where hypocenters and seismic stations are located in a two-dimensional space (i.e., plane) is considered; one is horizontal and the other is vertical. Also, the direction of the intermediate principal stress (σ_2) and that of a fault plane of each earthquake are supposed to be vertical to the considered plane. The spatial variation of the plunge of the direction of the maximum principle stress (σ_1) is assumed to be follow a particular pattern (and consequently, the direction of the minimum principle stress σ_3 is also determined). Under these conditions and assumptions about the directions of a fault plane and seismic slip as described above, datasets of P-wave first motions are generated. Then, the proposed Bayesian approach is applied to these datasets. As a result, the estimated spatial pattern almost agrees with the one assumed in the generation of the simulation datasets, which suggests the validity of developing this Bayesian approach.

Keywords: stress field, spatial pattern, P-wave first motion, Bayesian estimation