Near-Field Ground Motion Simulation based on Depth-Dependent Stress Accumulation Model I, Interpretation of the 2019 Mw4.9 Le Teil earthquake

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The earthquake rupture process is complex and heterogeneous related to the stress field and frictional condition in a fault system. The lateral heterogeneity is often discussed in relation to the fault geometry and past history. The depth variation of frictional rheological behaviour depending mainly on the temperature is well known, and this has been applied on modelling of characteristic earthquakes. However, many moderate earthquakes ruptured not the entire seismogenic zone depth but only a limited range of depth. The 2019 Mw4.9 Le Teil (France) earthquake showed a surface rupture along the known fault trance, and the ruptured area is limited in the first 2 km at most from the inversion results (e.g. Delouis et al., 2019; Ritz et al., 2020). From the viewpoint of seismic hazard assessment, it is a crucial question why this earthquake occurred in such unexpected, limited depth range. Previously, Aochi and Tsuda (in revision, 2022) constructed the on-fault stress field, which is loaded on the layers' rigidity. For the case of Le Teil earthquake, there is a stiff layer of high rigidity at the depths between 600 m and 1200 m according to the seismic inversion. We could interpret that this layer is only enough loaded by compressional principal stresses. The numerical simulation demonstrated that the lateral extension of the rupture at depth layer triggered the shallow part of the fault unfavourably loaded, but not the deeper part. In this study, we focus on the fact that the shallow part is ruptured with a delay, and this should be important in near-field ground motions. The variation in ground motion becomes smaller in the very near-field (Figure 1), as a strong directivity effect along dip disappears. It will be a further topic to establish the mechanical model of stress loading in slow deformation area, but our simple assumption allows to guess the probable stress field along the fault dip.

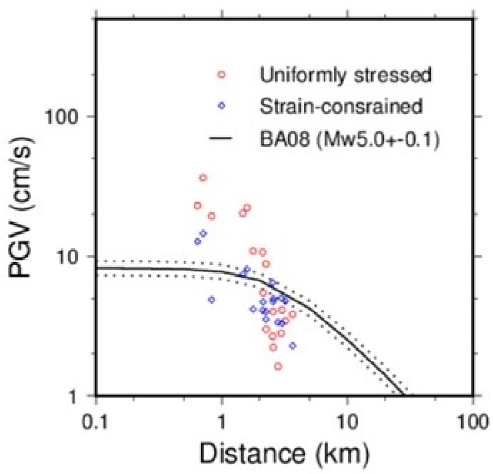

Figure1 (a) The comparison of the Peak Ground Velocity (1 component) in the randomly distributed receivers around the M4.9 earthquake model. The blue diamondes shows the model having the stress constrained by layer's rigidity, comparing to the model assuming the uniformly loaded plotted by red circles. The solid line shows an expected level from BA08 with a standard deviation by dotted lines.