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# On the Rupture Dynamics of Shallow Dip-Slip Faulting in a Stratified Medium

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One significant feature of a shallow dip-slip earthquake is the broken symmetry of seismic motion in the proximity of the rupturing fault plane. In general, the strong motion is much larger on the hanging wall than on the footwall, but the mechanics behind this asymmetry has not been wholly understood yet. Therefore, in this contribution, based on finite difference calculations and dynamic photoelasticity, we try to deepen our understanding on the rupture dynamics of a shallow dip-slip fault plane numerically as well as experimentally. In our two-dimensional crack-like rupture models, a flat vertical or inclined fault plane is prepared in a monolithic (first model) or stratified (second model) linear elastic medium. In the basic first model, as predicted numerically by Uenishi and Madariaga (Eos 2005), the primary fault rupture approaching the horizontal free surface may induce four Rayleigh-type waves, two Rayleigh waves propagating along the free surface to the far field and the other two interface waves travelling back downwards along the ruptured fault plane. In the case of the inclined fault plane, the interaction of the interface and Rayleigh waves may generate a strong shear wave (corner wave) and cause stronger disturbances in the hanging wall. The corner wave may exist only when the fault plane is asymmetrically inclined. On the contrary, in the second model, symmetry of seismic motion may be broken even in geometrically symmetric cases if the secondary rupture is allowed at an interface between geological layers. For instance, if primary vertical fault rupture propagates from depth and interferes with a horizontal interface obeying a tensile fracture criterion, the interface segments on which the primary fault rupture produces dynamic compression (in the relatively rising hanging wall) may remain unbroken and only some interface segments in the subsiding footwall may be fractured in tension. That is, in the hanging wall, the dynamic disturbances in the upper layer above the interface become rather strong since the rupture front wave (induced by the primary fault rupture) can move across the still connected interface into the upper layer while, in the footwall, the rupture front wave may be reflected at the fractured interface and dynamic stresses in the upper layer may become smaller. Hence, (each or combination of) the simple two models may explain the reason for the stronger seismic motion in the hanging wall. As a case study, we consider the recent Nagano-ken Hokubu (Kamishiro Fault), Japan, earthquake that occurred on 22 November 2014.