Mechanics preserving co-seismic uplift and marine terraces: dissymmetric patterns of co-seismic and inter-seismic deformation

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Four large Holocene marine terraces are known in the southern part of the Boso Peninsula and called Numa I - IV. The newest one (Numa IV) was uplifted at the time of the Kanto Genroku earthquake, and from the similarity of the spatial distribution, it was considered that the Numa I-III Ire also formed from uplifts during the Genroku-type events. From this, the amount of coseismic uplift and slip amount were estimated from the height of the terraces (Matsuda et al., 1978; Nakata et al., 1980; Namegaya et al., 2011; Sato et al., 2016 etc.). However, the relationship between Holocene marine terraces and paleoseismic events was doubted in previous studies (Matsu'ura and Sato 1989, Noda et al., 2018). There is Matsu'ura and Sato (1989) model which is a mechanical model explaining the long-term surface uplift. This model expresses seismogenic region by back slip at the interseismic period and forward slip at the coseismic period and givessteady forward slip along the whole plate boundary surface. From this model, the coseismic vertical displacement pattern cancel out and the interseismic one and the uplift accumulation on the surface was attributed only to the effect of the steady-state plate motion.However, this is consequence based on a simple model expressed that slab as one plane in horizontal layered structure and assumed that the amount of back slip at the interseismic period and the amount of forward slip at the coseismic period are equal. The purpose of this study is to verify whether the coseismic uplift amount records the slip amount and remains and accumulates over earthquake cycles, and it affects coastal terrace formation process in a general mechanical model, considering the shape of the slab, the plate motion, and the coseismic fault motion.
As the calculation procedure, first, We give a constant displacement (10 m) to the edge of the oceanic plate and accumulate strain on the plate boundary. Next, We release all accumulated shear stress by coseismic fault slip,and obtain the vertical displacement pattern on the surface and the slip amount on the plate interface. Based on the fact that the principle of superposition is established in the linear elasticity theory, in this study, We separated the boundary conditions of both the interseismic period and the coseismic period,and calculated the respective vertical displacements and the residual amount by taking the sum. To verify the influence of irregularities on the actual plate boundary surface on the spatial pattern of vertical displacement, We also calculated two patterns for the case where irregularities were locally placed on the plate interface.
As a result of the calculation, we found that the interseismic slip amount in the no-cuppled area converged to 0 in the vicinity of the coupled area, and the coseismic slip amount was not uniform, and occurred across the plate boundary surface. This suggests that the slip on the plate boundary is intermittent in the seismic cycle. Next, from the vertical displacement residuals, we found that their spatial patterns at the interseismic period and the coseismic period were different.Furthermore, when local irregularities are placed on the plate boundary surface, it was found that the spatial pattern of the coseismic uplift is different corresponding to the slip amount of each model. This suggests that the height records the slip amount, and the shape of the plate boundary surface attributes actual coastal terrace formation. The consequence of this study is that the slip on the plate boundary is intermittent, and the coastal terraces depend on the coseismic slip.Therefore, the model in this study will give meaning to estimate the paleoseismic image from the height of coastal terraces.

Keywords: paleoseismic, mechanical model, Holocene marine terraces