The effect of far-field tectonic stress and plate-scale rheology on intraplate seismicity

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Paleoseismological and historical evidence shows that a few intraplate seismicity has been episodically active and dormant within many stable continental regions. The spatiotemporal prediction of which intraplate fault slips seismically remains a highly debated issue because all intraplate faults simultaneously accommodate far-field tectonic stress from the plate boundary. Thus, there arises complicated stress feedback among the faults surrounding the upper and underlying lower crust and upper mantle. I conducted visco-elasto-plastic two dimensional finite element modeling to investigate the influence of far-field stress and the viscoelastic rheology of a plate system on the occurrence of an earthquake in an intraplate setting, where faults exist far from the plate boundary. In this model, the far-field tectonic stress, single or multiple faults, fault-embedded plate, loading plate, and plate boundary are included as components. Since the two plates are deformable, the effective far-field stress can change over time during the accumulation and release of stress from the faults, and the seismic recurrence period of the fault is self-consistently determined. The calculated results based on the ratio between the viscosity of the fault-embedded and loading plates (i.e., $R_{viscosity}$), and the ratio between the far-field constant stress and elastic limit of the fault (i.e., R_{stress}) demonstrate that the recurrence period becomes shorter as $R_{viscosity}$ increases and R_{stress} decreases. Although there is a complicated variation in recurrence periods due to stress transfer in multiple fault cases, $R_{viscosity}$ and R_{stress} primarily determined the time-averaged recurrence period of each fault. Moreover, this trend prevailed even when initial pre-stress was randomly assigned in terms of the spatial arrangement and orientation on the fault-embedded plate. This indicates that the rheology of the plate system represented by $R_{viscosity}$, and the far-field stress represented by R_{stress} can influence the probability of earthquake occurrence. My study suggests that the perspective of a plate system should be the basis of explanations for the seismic behavior of continents over a long time scale, rather than local and short time scale stress change.