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不均質応力場での動的地震破壊における熱・流体の効果
The effect of heat and fluid on dynamic earthquake rupture in inhomogeneous stress field

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We numerically investigate the effect of the interaction among heat and fluid on dynamic fault tip growth. The interaction, referred to as thermal pressurization (TP), is briefly summarized as follows. When fault slip occurs, frictional heat source appears and it raises fluid pressure. The high-pressured fluid reduces effective normal stress acting on the fault plane, which reduces the frictional stress. This frictional stress reduction enhances the fault slip and the heat source term is again changed. TP is therefore regarded as positive feedback in dynamic fault slip process. Though this mechanism has been studied widely, there has been a problem that many researchers have assumed homogeneous model setup. Natural faults show inhomogeneity in many aspects such as material properties and stress field. For example, the slab beneath Tohoku shows compression (upper zone) and tension (lower zone) stress field and earthquakes are observed to propagate in such stress field. In addition, fluid dehydrated from rocks is believed to exist in and around the slab and it is expected that TP works strongly in the region. We should therefore consider how TP works in inhomogeneous stress field.

We assume dynamic fault tip growth in a thermoporoelastic medium; thermoporoelastic medium has been assumed by a number of researchers to treat TP. Spontaneous fault tip growth with the Coulomb fracture criterion is assumed. Shear stress acting on the fault plane is assumed to decrease linearly with distance from the rupture nucleation point, which generates the region where the shear stress acts in the opposite direction. We can therefore expect that the fault tip growth is arrested spontaneously if we do not consider TP.

The fault tip with TP is found in our calculations to extend to the region where the shear stress changes its direction from the nucleation point, which occurs because of the positive feedback due to TP. If the spatial change rate of the shear stress is smaller, the fault tip can grow further. The results obtained here may explain the reason that earthquakes occurring in, for example, the Tohoku slab can extend over both compression and tension regions.

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