On the Mechanical Relation between Individual Interaction and Collective Behavior of Multiple Fault Sets Subjected to Quasi-Static Loading

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In order to deepen our essential understanding of the connection between the local and the global or collective mechanical behavior of sets of geological faults in the solid earth, we have been performing laboratory rupture experiments using two-dimensional rectangular, linear elastic solid specimens with preset parallel cracks that model multiple fault planes under quasi-static tensile (mode-I) or tensile with in-plane shearing (mixed mode) loading conditions (Uenishi et al., SSJ Fall Meeting, 2017, 2018). Our special attention has been paid to the identification of when and how ruptures develop on each individual fault plane and interact with one another, and how the interaction influences the global nature of the solid. For that purpose, we have observed the local evolution of the isochromatic fringe patterns, i.e. the contours of the maximum in-plane shear stress, around the modeled fault planes in the photoelastic polycarbonate specimens with a high-speed digital video camera. At the same time, we have measured the global stress-strain relation utilizing a tensile testing machine that externally exerts a prescribed constant displacement rate to the specimen, and have compared its time history with the local observations of the isochromatic fringe patterns. Although the externally applied displacement or strain rate has been still in a relatively low, quasi-static range, the comparison may imply the effect of the local rupture development on the global properties of the solid specimen, and we have found that local rupture may not always propagate unidirectionally in the prepared specimens and ruptures may run into each other even on a single fault plane under very simple external loading conditions. We are now trying to investigate the mechanical characteristics of multiple fault sets that are subjected to more dynamic, impact loads and identify difference in the local-global relation, if any, between the dynamically-controlled and quasi-statically governed ruptures.

キーワード：fault rupture、fault stability、strain rate
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