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Typical phases of shear fault formation in granitic rocks

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The faulting process in brittle rock samples subjected to differential compression was investigated in detail based on acoustic emission (AE) data collected with a high-speed multi-channel waveform recording system [1]. The experimental results exhibit a faulting process characterized by three typical phases of microcracking activity: the primary, secondary, and nucleation phases, respectively [2]. The primary phase reflects the initial opening or rupture of pre-existing microcracks, and is characterized by an increase in the stress effect in the energy release rate and b value in frequency-magnitude distribution of AE events. The secondary and nucleation phases involve sub-critical growth of the microcrack population in the test sample, revealed by an increase in energy rate and a decrease of the b value with increasing stress. In order to investigate the fracture mechanism of each phase, a damage model based on stress corrosion constitutive laws for sub-critical crack growth of crack populations with fractal size distribution was improved and examined using the experimental data. By employing the improved model, the energy rate and b value obtained during the secondary and nucleation phases can be represented very well. The nucleation phase corresponds to the initiation and accelerated growth of the ultimate shear fault and shows hierarchical behaviors [3]. Quasi-static nucleation of faults represents dynamic fractures of the asperities on the fault plane; likewise, a quasi-static nucleation process characterized by dynamic microcracking precedes the fracture of an asperity. The progressive fracturing of multiple and coupled asperities results in short-term precursory fluctuations in both the *b*-value and energy release rate of AE. This result indicates that precursor-based predictability of fault fracture strongly depends on the heterogeneity on the fault plane.

Keywords: Experiment; Acoustic emission; b-values; Fault nucleation.

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