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Statistical evidence of hierarchic transition during controlled rock fracture

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We present the chronological series of acoustical emission signals detected in samples of Westerly granite loaded at two regimes. The first regime included a feedback loop between the axial stress and AE activity, while the second one used the loading at the constant rate of deformation. It was found that the fracturing system evolves without a characteristic scale of the energy release and with the same scaling exponent independently of the applied feedback. At the same time, the scaling properties of the energy release distribution become stronger as the fracture process approaches to its final stage. The distribution of distances between appearing hypocenters follows the power law with the exponent that does not depend on the mode of loading. However, in contrast to the monotonic transformation of the energy release function to the power-law distribution, the spatial characteristics of the newly-appeared damaged sites exhibit a more complicated behavior. In both regimes, a transient period of the decorrelated accumulation of damaged sites was revealed between the initial and focal stages of the fracture process. The scaling properties of the waiting-time distribution are sensitive to both the drive control and the stage of fracture process. As like as in the case of spatial distribution, a transient loss of the temporal correlation between individual fracture events was revealed at the pre-focal stage of fracture process. The existence of periods of the lack of the space-time correlation is the response of the avalanche dynamics to the hierarchic transition in the system when the clusters of damages of lower hierarchic level commence to form damages of higher level. Such the period is characterized by a combination of the exhausted “weak points reservoir” at the lower level with the insufficient statistics of large events at the upper level.