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On the Relationship between the Omori and Gutenberg–Richter Parameters in Aftershock Sequences

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The issues concerning the relationship between two self-similarity parameters—the Gutenberg–Richter b- and Omori p-values—in the aftershock sequences are explored. In the laboratory experiments, under fracture initiation in the rock by sharp jumps in the axial stress, a correlation between the p- and b-values is revealed in the fracture relaxation regimes similar to aftershocks. The correlation observed in the experiments on water-saturated sandstone samples with the preliminarily formed faults is negative and clearly pronounced. The correlation in the case of dry samples of migmatite and concrete proved to be positive, but its statistical significance is lower than for the wet samples. The analysis of the literature data on detecting the connection between parameters p and b in the natural aftershock sequences shows that the reported results are heterogeneous. Some authors conclude that these parameters are connected and that both positive and negative correlation is noted between them. Other authors present evidence suggesting the absence of any correlation. Our study of the natural aftershocks based on the data of regional earthquake catalogs has shown that the statistical estimates of the Gutenberg–Richter and Omori parameters are fairly sensitive to the quality and homogeneity of the input data. The key factors affecting the estimation quality of these parameters are established, and the procedure for selecting the aftershock catalogs for subject analysis is developed. The results of statistical estimating the Gutenberg–Richter and Omori parameters in the aftershock processes in the regions with different types of the tectonic regimes—subduction zones and regions of shear transform faults—have shown that that the correlation of these parameters in the subduction zones can be positive and negative either. In the zones of the transform faults, the connection between these parameters is not detected. Our study generalizes C.H. Scholtz's idea that the Omori law can be explained by the superimposition of the relaxation processes having different relaxation times. According to the generalized model, the different sign of the correlation between the self-similarity parameters in the aftershock processes correspond to the different relaxation mechanisms with different types of the dependence of the relaxation time on the "size" of the relaxator. It is currently unclear which particular mechanisms are implemented in the aftershock processes. The relationship between the Omori and Gutenberg–Richter parameters revealed by our laboratory experiments and field studies (positive correlation, negative correlation, or lack of

correlation) may indicate the implementation of different relaxation mechanisms in some or other particular conditions.

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