FRACTAL STRUCTURES OF SPATIAL DISTRIBUTIONS OF AFTERSHOCKS AND ACTIVE FAULTS

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The relationship between the fractal structures of spatial distributions of aftershocks and active faults is studied. 14 main shocks occurring in Japan are followed by aftershocks taking place in swarms around the main shocks. The epicentral distributions of the aftershocks display fractal structures with the estimation of the fractal dimensions by using the two-point correlation integral. The spatial distributions of pre-existing active faults observed in the aftershock regions show fractal structures with the estimation of the fractal dimensions by using the box-counting method. A positive correlation between the above two sets of fractal dimensions is found, indicating that aftershock distributions become less clustered with increasing the fractal dimensions of pre-existing active faults. The correlation shows that if the fractal dimension of active faults is the upper limit of the fractal dimension of actual rock-fracture geometry, then the spatial clustering of aftershocks is completely random and unpredictable. It is concluded that the fractal clusters of aftershocks are put under the constraint of the fractal structures of pre-existing active faults. Our results are discussed from the viewpoint of self-organized criticality in a nonconservative earthquake model, electromagnetic radiation and 'cumulative Benioff strain-release relationship' that can contain log-periodic oscillations and suggest the discrete scale-invariant process of sequential fractures.