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Model of Earthquakes Exhibiting Self-Organized Criticality with Roughness of Self-affine Fault Surfaces: Statistical Properties of Constant Stress Drop and b-value of 1

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Earthquakes (EQs) are natural phenomena involving frictional slip and fracture processes on geological fault surfaces that are caused by tectonic plate motion. Burridge and Knopoff [1967] proposed a primitive spring-block EQ model called BK model. Carlson *et al*. [1991] showed the BK EQ model, behaving like self-organized criticality (SOC), yield Gutenberg-Richter (GR) law qualitatively. Later, many works of BK model have tried to show some statistical properties such as GR law, constant stress drop and Omori law [Main, 1996]. However, these works mainly did not consider the fault surface structure and some of these works, b-value is similar to 1.5, so it is not satisfied the observation result.

In the present paper, we numerically investigate a one-dimensional BK model with inhomogeneous fault surfaces consisting of self-affine fractals, because the self-affinity of fault surfaces has been experimentally obtained on a scale range from 10 μm to 40m [Power, *et al*., 1991]. Thus, we introduced two parameters for such a self-affinity in BK model: (1) Normalized spring modulus modeled by the velocity of seismic wave propagation. (2) Friction function parameter.

In both case (1) and (2), b-value depends on the Hurst (roughness) exponent H, which is a represented value of self-affine fractals. On the other hand, stress drop does not depend on H. Thus, we conclude that b-value depends on the fault surface roughness, and constant stress drop does not depend on the fault surface roughness. Therefore, we

can demonstrate the GR law and constant stress drop at the same time quantitatively and qualitatively. We also conclude that reasonable of H ranges from 0.7 to 0.9 through observations. According to the fault-surface observation, Hurst exponent H of cross section of fault surfaces is nearly equal to 0.8 [D. Amitrano, *et al*. 2002]. Our result also satisfies this observation result.

References

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