A Note on the Correlation between b-value and Fractal Dimension from Synthetic Seismicity

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ABSTRACT

Seismicity is dynamically simulated by one-dimensional mass-spring model with fractal distribution of breaking strengths. A linearly rapidly-weakening-and-hardening friction law controls the sliding of the mass. The frequency-magnitude relations from synthetic seismicity for five values of fractal dimension show that b-values for events with intermediate magnitudes are close to 1, while those for events with larger magnitudes are from 1.68 to 2.52. For small events, the *logN* values are almost constant.

1. INTRODUCTION

Gutenburg and Richter (1955) first mentioned the linear law between $\log N$ and M, where M is the earthquake magnitude and N is the cummulative frequency of earthquakes with magnitude greater than M, in the following form: $\log N = a - bM$. The b-value varies from region to region and is also dependent upon the used period of time, but is generally in the range of from 0.8 to 1.2. The variation of b-value before and after a major earthquake has been as an earthquake precursor (Smith, 1986; Chen *et al.*, 1990). The b-value is also correlated to geotectonics (Wang, 1988; Tsapanos, 1990). An understanding of physical basis of b-value would be significant to the studies on earthquake generation process and earthquake prediction.

Earlier studies on the physical processes associated b-value were primarily based on laboratory work of rock fracture. Mogi (1967) reported the effect of degree of heterogeneity of the media on b-value. Schulz (1968) correlated the increase of b-value with the decrease of the ambient stress level. Recently, numerous theoretical studies have been done to explore the relation of b-value with fault structure and fault dynamics. The studies are based on several aspects of physics: 1. fragmentation of materials (Turcotte, 1986a); 2. fractal distribution of strain and stress of crustal deformation (Turcotte, 1986b); 3. percolation

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