A Mechanism Causing the Temporal Variation in b-values Prior to a Mainshock

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Observations exhibit the temporal variation in b-values prior to a mainshock. The b-value starts to increase from the normal value at time t_1, reaches its peak one at time t_2, then begins to decrease from the peak one at t_2, and returns to the normal one at time t_3. As $t>t_3$, the b-value varies around the normal one or rightly decreases with time until the occurrence of the forthcoming mainshock at time t_4. The precursor time, $T=t_4-t_1$, of b-value anomalies prior to a forthcoming mainshock is related to the magnitude, M, of the event in a form: log(T)=q+rM (T usually in days) where q and r are two constants. In this study, the mechanism causing b-value anomalies prior to a mainshock is explored. From numerical simulations based on the 1-D dynamical spring-slider mode proposed by Burridge and Knopoff (1967), Wang (1995) found a power-law correlation between b and s, where the parameter s is the ratio of the spring constant (K) between two sliders to that (L) between a slider and the moving plate. The power-law correlation are $b\sim s^{-2/3}$ for the cumulative frequency and $b\sim s^{-1/2}$ for the discrete frequency. Since L of a source area is almost constant for a long time period, b directly relates to K. Lower K results in a higher b-value. Wang (2012) found $K=\rho_A v_p^2$, where ρ_A and v_p are, respectively, the areal density and P-wave velocity of a fault zone. Experimental results show that v_p is strongly influenced by the water saturation in rocks. The water saturation in the source area varies with time, thus leading to a temporal variation in v_p as well as K. This results in the temporal variation in b-values prior to a mainshock. The modeled result is consistent with the observation.

Keywords: earthquake precursor, b-value, precursor time, earthquake magnitude, water saturation, spring-slider model

