A Mechanism Causing 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 model 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 $b-s^{-2/3}$ for the cumulative frequency and $b-s^{-1/2}$ 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 $K=rAv_p^2$, where $r_A$ 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 observed one.

Keywords: b-value, precursor time, spring-slider model, stiffness ratio, saturation of water