Spatio-temporal changes in b-value and their physical significance for several moderate earthquake sequences occurred in Japan

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This study is the result of our ongoing efforts to identify spatial and temporal seismicity patterns and to find their correlation with changes in the stress-state and/or structure of the crust. We focus our attention on the frequency-magnitude distribution for several earthquake swarms occurred in Japan. In order to understand better the relation between the stress and b-value changes, we compute the Coulomb failure stress for the major earthquakes in each case.

Firstly, we analyze the spatio-temporal distribution of b-values for the 1998-1999 Hida Mountain earthquake swarms. We have relocated the events recorded by Kyoto University during a campaign of intense observation. Using these relocated events, we found a b-value of 1.1-1.2 in the south and of 0.5-0.6 in the north region, respectively. However, a detailed analysis shows that b-value is changing also as a function of time: smaller values (06-0.9) are found generally for time periods characterized by the occurrences of moderate events, while larger b-values (1.0-1.4) are found for periods without moderate (or large) events.

As a second case, we analyze the b-values for the 2001 Northern Hyogo prefecture earthquake swarm, by using JMA data. The b-value is found to vary spatially, with 'normal values' of about 1.0 in the western and northern parts and significantly larger ones, 1.3-1.4 in the east part. A more detailed analysis reveals, however, that this change is in fact a temporal one: for the first part of the swarm, characterized by the occurrence of several moderate shocks, the b-value is about 1.0, but increases afterwards, reaching a rather stable value of about 1.3-1.4.

In the third part of the study, we analyze the swarm-like seismic activity occurred in September-October 2002, in the vicinity of Daisen volcano, in Tottori prefecture. We observe similar time variations of b-value as in the previous cases.

All the above results point out that the changes in b-value are a complex spatio-temporal pattern. While the Coulomb failure stress and/or the crustal structure may explain some of the changes in b-value, there are cases that cannot be explained in such ways. This shows that careful studies for many more cases are necessary, before drawing definite conclusions or interpreting the results. We are currently processing other swarm-like data sets, which, we hope, may reveal new information on the physical processes that govern the frequency-magnitude distribution changes.