

Parallel and Focused Increase Trends in Time Series (M-T Diagram) of Earthquake Occurrences

*Satoshi Hashimoto¹

1. none

Usually time sequence of earthquakes is not used as continuous variations because of special property of its occurrences. A few cases such as aftershocks and repeated earthquakes are attributed to continuous series. However, in a time series downloaded from HP of earthquake catalog continuous increase variations are seen clearly in almost all M-T diagrams, here M and T mean magnitude and occurrence time of earthquakes, respectively.

For example, since 2000 a time series of earthquake is shown under the conditions that $M > 5.5$, D (depth) $< 50\text{km}$, and main 4 islands of Japan with sea areas. In this series clear increase trend consisted from 13 earthquakes ($M > 6$) can be recognized on a time period from 2002 to 2005. Note that 3 points deviated largely from the straight line are excluded. Surprisingly the straight line connects roughly to the M9 of 2011/3/11 Tohoku-oki Earthquake. If we focus our attention to the increase trend, several lines with similar slope can be seen in other time durations since 2000. These lines are parallel with each other and interrupted at some value of M.

One more important character is seen in the M-T diagram since 2000. Before 2011/3/11 extrapolated more lines gather to the value M9 of Tohoku-oki Earthquake in detailed observations. These are called focused lines. Focused lines are coexisted with the parallel series. Both series are exhibited in whole time span of about 100 years of the catalog. The excluded points described above are probably included by other parallel or focused lines. In short, almost all earthquakes are included in many increase trends of earthquake time sequences.

Little work has been done to the regularity shown above. If several focused time series are found for a few and several years at present, extrapolation of the series will cross in near future. Just the crossing point is the predicted point.

In order to obtain further information about two kinds of the time series, several blocks of Japanese islands are analyzed together with sea areas. From the results two kinds of the time series can be seen in the all blocks. In a small region, increase trend of $M \sim 7$ does not appear, but in a case of $M \sim 6$, focused trends are also seen. This fact means that possibility of the prediction is successfully performed to $M \sim 6$.

Appearance of two kinds of time series is not understood at present. Statistical rule of earthquake occurrences called G-R (Gutenberg-Richter) law is well known. This is one of the power laws, in which number of very large earthquakes are very small, and number of small earthquakes are order of magnitude greater than that of large earthquakes. Comparison of this law with the present results can give us important suggestion. This law does not include the factor of time. Present results shows linear increase trends are very simple but real time series are very complex. Time plays main role in the time series. G-R law is obtained from just after many earthquake occurrences. Present results do not show the individual earthquakes, but show continuous processes in earthquake preparation time span.

At the first stage of this study, present trends are presumably attributed to the constant rate of strain

energy accumulation. However, this idea does not interpret the both parallel and focused trend in the time series. Namely mechanism that long time of several years are spent for accumulating the energy is not adequate in the present results. Perhaps critical state of the crust on the earth did exist hundreds of millions of years ago. At present the state can occur the earthquake both at all time and all places, crust give rise to the earthquake occurrences depending on the time durations. Trial of the prediction is now under planning, but origin of the mechanism is an important problem to be solved.

Keywords: M-T diagram, Earthquake Time Series, Parallel Time Series, Focused Time Series