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ANALYSIS OF THE AFTERSHOCK SEQUENCES OF LARGE EARTHQUAKES IN IRAN

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Seismic sequences are referred to as series of earthquakes in a region that occur over a certain period of time. Typically, any seismic sequence consists of a main event and its associated events: foreshocks and aftershocks. Aftershock events are associated with smaller magnitudes and with a time interval of between several minutes to several years after the main seismic earthquake, and their abundance decreases over time, until the rate seismicity is returned to the seismic level of the background and the process of seismic events reach a stable state (Omori, 1894).

In this study, the decay of the earthquake aftershock sequences of some major earthquakes, in different tectonic regimes in the Iranian plateau such as; Rigan, Ahar-Varzaghan, Goharan, Saravan, Sefidsang and Ezgeleh earthquakes, considering different magnitudes of thresholds, M_c, are discussed based on different decay models (Utsu, 1961; Reasenberg et al., 1989; Kisslinger, 1993; Shcherbakov, 2004). After defining spatial and temporal windows based on the Gardner & Knopoff method, the graphs and parameters of each decay rate were computed and analyzed for each sequence. The decay rates of sequences were compared to the well-known models to find the best fit for each sequence. The rate of decreasing is not constant due to the changes in the threshold magnitudes. The best fit of the decay rates with the studied earthquakes data are in accordance with the threshold magnitude obtained from the Gutenberg-Richter relation. In addition, we studied the dependence of the parameters of the Omori law on the size of the threshold magnitudes. Figure 1, depicts the p and c parameters of the Omori law versus different threshold magnitudes for the studied earthquakes. We seek answer to the question if there is a correlation between the studied parameters in each time interval and the threshold magnitude? In this regard, the correlation between the p, c and p, b parameters for the studied earthquakes were analyzed for different time windows and presented in Figure 2.

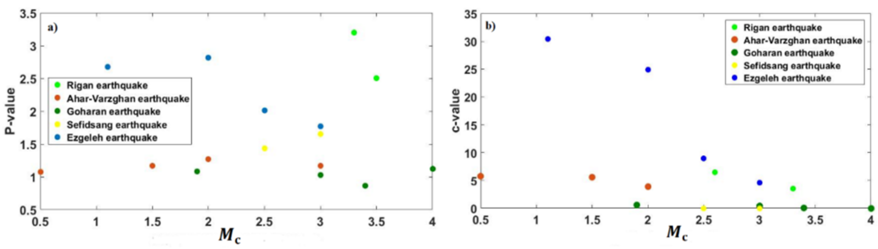

Figure 1. a) The changes of the p parameter and b) the changes of the c parameter of the Omori law versus different threshold magnitudes for the studied earthquakes.

In the following, we determined the type of aftershocks in the Ezgeleh earthquake sequence according to the method of Riga and Balocchi (2017). Figure 3 shows a branch structure for the Ezgeleh earthquake during 15 months. The red star is the main event with magnitude 7.3 M_N , the yellow stars are the primary aftershocks that are directly connected to the main event and the blue stars are recognized as the secondary aftershocks. The black, pink, green, light blue and dark blue lines which are shown in Figure 3, represent the first to fifth order of energy release branches with the letter (r) and the energy accumulation branches with the letter (a) for the aftershock sequence of Ezgeleh. The point AF_5 according to Bath's law is next main event, and it is possible that the pink stars in Figure 3 are the beginning of the occurrence of foreshocks of the Ezgeleh earthquake 6.4 M_N. Our study shows in most of the different threshold magnitudes of the studied earthquakes, the decay rate of the Omori at the short-term and the Kisslinger at the long-term has the best fitting with the sequences data and also be seen that the correlation between p and c parameters and p with the b parameter are not constant over time. The mean value of the parameter p, for the studied earthquakes, regarding the Omori law for the primary aftershock is 1.1. The mean value of the parameter p of the Reasenberg, Kisslinger and Shcherbakov values are 4.8, 0.53, 2.3, respectively.

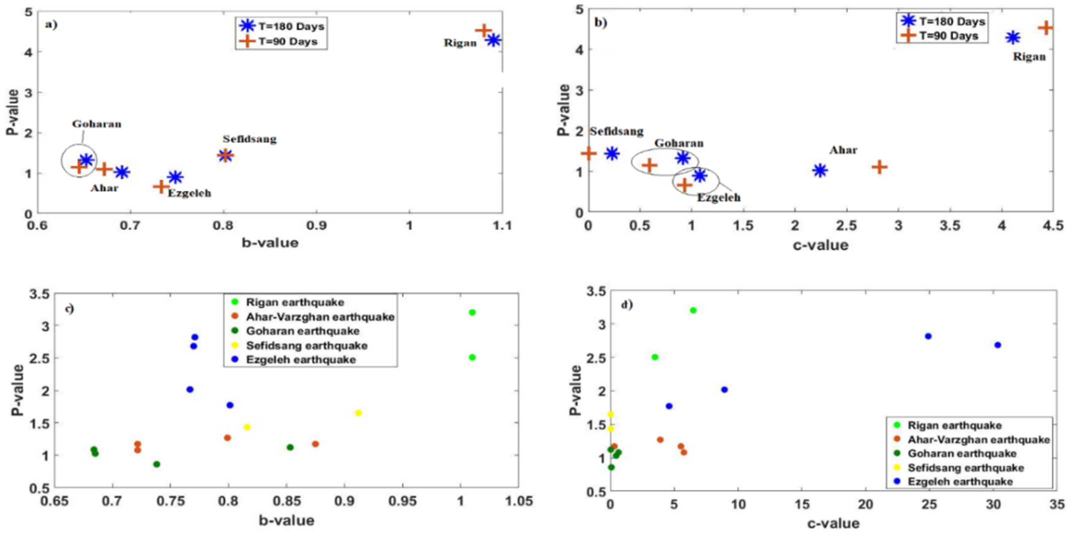

Figure 2. Correlations between parameters p and b and parameters p and c for different time windows (in panels a and b), correlations between parameters p and b, and parameters p and c, for different threshold magnitudes (in panels a and b).

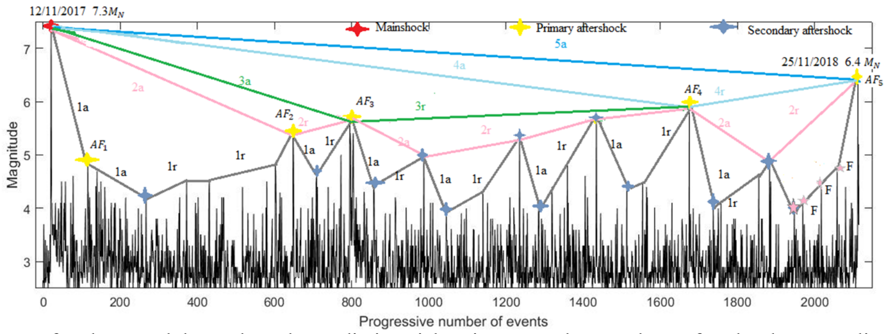

Figure 3. The branch structure for the Ezgeleh earthquake to distinguish primary and secondary aftershocks according to the method of Riga and Balocchi (2017).

REFERENCES

Kisslinger, C. (1993). The stretched exponential function as an alternative model for aftershock decay rate. *J. Geophys. Res.*, *98*, 1913-1921.

Omori, F. (1894). *On aftershocks*, Rep. Imp. Earthq. Inv. Corn., 2, 103-138 (in Japanese).

Reasenberg, P.A. and Jones, L.M. (1989). Earthquake hazard after a mainshock in California, *Science*, *243*, 1173-1176.

Riga, G. & Balocchi, P. (2017). Aftershocks identification and classification. *Open Journal of Earthquake Research*, *6*, 135-157.

Shcherbakov, R., Turcotte, D.L., and Rundle, J.B. (2004). A generalized Omori's law for earthquake aftershock decay. *Geophys Res. Lett.*, *31*, L11613.

Utsu, T. (1961). A statistical study on the occurrence of aftershocks. *Geophys. Mag.*, *30*, 521-605.