



Earthquake Recurrence Intervals in Complex Seismogenetic Systems

Andreas Tzanis and Angeliki Efstathiou

National and Kapodistrian University of Athens, Section of Geophysics and Geothermy, Zografou, Greece
(atzanis@geol.uoa.gr)

We examine the association of recurrence intervals and dynamic (entropic) states of shallow (crustal) and deep (sub-crustal) seismogenetic systems, simultaneously testing if earthquakes are generated by Poisson processes and are independent (uncorrelated), or by Complex processes and are dependent (correlated). To this effect, we apply the q-exponential distribution to the statistical description of interevent times, focusing on the temporal entropic index (measure of dynamic state), in connexion to the q-relaxation interval that constitutes a characteristic recurrence interval intrinsically dependent on the dynamic state. We examine systems in different geodynamic settings of the northern Circum-Pacific Belt: transformational plate boundaries and inland seismic regions of California, Alaska and Japan, convergent boundaries and Wadati-Benioff zones of the Aleutian, Ryukyu, Izu-Bonin and Honshū arcs and the divergent boundary of the Okinawa Trough.

Our results indicate that the q-exponential distribution is universal descriptor of interevent time statistics. The duration of q-relaxation intervals is reciprocal to the level of correlation and both may change with time and across boundaries so that neighbouring systems may co-exist in drastically different states. Crustal systems in transformational boundaries are generally correlated through short and long range interaction; very strong correlation is quasi-stationary and q-relaxation intervals very short and extremely slowly increasing with magnitude: this means that on occurrence of any event, such systems respond swiftly by generating any magnitude anywhere within their boundaries. These are attributes expected of SOC. Crustal systems in convergent and divergent margins are no more than moderately correlated and sub-crustal seismicity is definitely uncorrelated (quasi-Poissonian). In these cases q-relaxation intervals increase exponentially, but in Poissonian or weakly correlated systems their escalation is much faster than in moderately to strongly correlated ones. In consequence, moderate to strong correlation is interpreted to indicate Complexity that could be sub-critical or non-critical without a means of telling (for now). The blending of earthquake populations from dynamically different fault networks randomizes the statistics of the mixed catalogue.

A possible partial explanation of the observations is based on simulations of small-world fault networks and posits that free boundary conditions at the surface allow for self-organization and possibly criticality to develop, while fixed boundary conditions at depth do not; this applies

particularly to crustal transformational systems. The information introduced by q-relaxation may help in improving the analysis of earthquake hazards but its utility remains to be clarified.

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