Activation of Fault Systems Before Recent Largest Earthquakes Worldwide

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We discuss a novel understanding of seismic process, as an essential part of dynamics of a complex hierarchical system of faults. When case histories of the recent great earthquakes (with magnitudes 8 or above) are analyzed in detail within space-time of long-, intermediate-, and short-term scales we observe different stages of inverse cascade of seismic activity close to the epicenter of approaching large earthquake. At large scales a formalized definition of such phenomenon is used for a real-time prediction of earthquakes. The methodology of intermediate-term predictions is completely reproducible and statistically verified at the 99% confidence level.

Statistical validity of predictions confirms the underlying paradigms: existence of premonitory earthquake space-time patterns, large size fault system involved in formation of these phenomena at the scale of years, partial similarity of them in a wide range of tectonic environment, and their certain universality. Our findings provide constrains to modeling seismic activity. At fine scales the phenomenon of premonitory rise of seismic activity is hard to reveal in some cases due to evident incompleteness at small magnitudes of the global databases available and, therefore, remains a subject of debate. However, when regional or local catalogs of earthquakes are used the methodology permits a hierarchical step-by-step refinement of the accuracy, in some cases, to the size of incipient earthquake as exposed by distribution of aftershocks.

We present several recent case histories that show certain escalation of activity at narrowing space-time-energy scales from the prospective of hierarchical self-organization.