



Reverse tracing of precursors of large earthquakes.

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We describe the methodology for detecting earthquake precursors with characteristic lead time months. Physical mechanism underlying this methodology comprises interaction of two processes in a fault network: accumulation of energy that the earthquake will release; and triggering that release by decrease of the network's integral strength. These processes are captured by an ensemble of seismicity patterns. Methodology detects such patterns by tracing dynamics of seismicity backwards in time; accordingly, it is named "Reverse Tracing of Precursors" (RTP).

First, we detect shorter-term precursory phenomenon (with characteristic lead time months): rise of earthquake correlation range. This phenomenon is detected by occurrence of specific clusters of epicenters of moderate earthquakes called "earthquake chains". The earthquake chain is a cluster of epicenters formed by "neighbors" and extending over large distances (an order larger than the length of the future strong earthquake). Neighbors are statistically rare pairs of epicenters close in space and time.

Second, we consider intermediate-term patterns (with characteristic lead time years) in the vicinities of the chain. Pattern recognition rule, "Hamming distance", helps to select premonitory earthquake chains from false alarms. Strong earthquake is expected in the vicinity of precursory chain for time T . Retrospective analysis suggests $T=9$ months.

First results of the ongoing test of the prediction algorithm RTP in California, Japan, Middle East, and Italy, started in June, 2003 are very promising: among six alarms two were successful predictions, two more alarms were near misses; one was false alarm,

and one is current alarm.

The principles of RTP are not specific to earthquakes and might be applicable to the wider class of hierarchical non-linear systems.