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A unified approach of geological and biological catastrophic events

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Both, earthquake and epileptic seizure involve interacting threshold elements. A large event, i.e. a seismic shock or an epileptic seizure, is a result from the repeated nonlinear interactions among their subunits, namely, opening cracks (that emit electromagnetic emission) or firing neurons. A common hallmark of these out-of-equilibrium phenomena is their extraordinary complexity. Complex systems self-organise their internal structure and their dynamics showing novel and surprising macroscopic properties including coherent large-scale collective behaviours. A basic reason for our interest in complexity is the striking similarity in behaviour close to irreversible phase transitions among systems that are otherwise quite different in nature. Recent studies have demonstrated that a large variety of complex processes, including earthquakes, forest fires, heartbeats, human coordination, neuronal dynamics, exhibits statistical similarities, most commonly power-law scaling behaviour of a particular observable. Interestingly, authors have suggested that earthquake dynamics and neurodynamics should have many similar features and could be analyzed within similar mathematical frameworks.We attempt to verify this hypothesis. Herein, by monitoring the temporal evolution of the fractal spectral characteristic in EEG (electroencephalogram) time series and pre-seismic electromagnetic time series we show that many similar distinctive symptoms (including common alterations in associated scaling parameters) emerge as epileptic seizures and earthquakes are approaching. These alterations reveal a gradual reduction of complexity as the catastrophic events approach. The transition from anti-persistent to persistent behaviour may indicate that the onset of a severe crisis is imminent. The observations find a unifying explanation within the school of the ‘‘Intermittent Criticality”. The observed here similarities in precursory features in seismic and epileptic behaviour further supports the hypothesis that the detected EM anomaly could have originated during the preparation of the Athens EQ.

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