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Intraplate paroxysms

João Fonseca
(jfonseca@tecnico.ulisboa.pt)

Earthquake science received a decisive boost from Reid's elastic rebound model in 1910 and from plate tectonics in the sixties. Both theories highlight the first-order accumulation of elastic strain energy near 2D discontinuities of the material properties of the crust. The second-order process whereby stresses build-up within 3D crustal blocks has remained obscure, because the available seismological data are swamped by interplate events. That notwithstanding, highly destructive earthquakes have originated away from plate boundaries or other previously identified faults. This includes the most destructive earthquake in human history - the Shanxi earthquake of 1556, with 830K fatalities - and more recent events such as the Tangshan earthquake of 1976 with ~250K fatalities.

In 2012, an intraplate earthquake of magnitude 8.6 provided unprecedented data for this type of phenomenon, revealing striking differences with respect to common observations pertaining to interplate earthquakes. Of paramount relevance is the role of a very complex network of disconnected structures, spreading the moment release over a broad footprint. I propose the name of "intraplate paroxysm" for this type of great (M>8) earthquake, to stress that it has distinctive characteristics, and most likely distinctive nucleation processes that beg investigation.

In this paper, I explore the observations that pertain to the 2012 Indian Ocean earthquake to discuss the data concerning the 1755 Lisbon earthquake, arguing that this event must be regarded, at least in part, as an intraplate rupture, and may share some of the features. The need to analyze this class of phenomena without the constraints of the interplate model is highlighted. In particular, magnitude estimation for historical intraplates earthquakes is particularly challenging, possibly because of inadequate premises. I argue that the observations of 1755 do not imply such an extreme moment magnitude as is often adopted (8.5-8.7) if some features of intraplate earthquakes are adopted, such as the broad footprint of moment release. A moment magnitude of 8.1 +/- 0.5 is, in my view, more consistent with the data, an observation with obvious implications for hazard assessment.