

Effects of fluid propagation on occurrence of doublet earthquakes

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Most earthquake sequences consist of a main large event preceded and followed by a series of smaller magnitude quakes commonly referred as to fore- and after-shocks. However, seismic catalogs report many examples of earthquake sequences featuring two or more main events of comparable magnitude. Such events are often referred as doublet earthquakes and are particularly observed in environments characterized by a large number of faults. Doublet earthquakes occur all over the world representing a significant issue in terms of seismic hazard assessment after large events. Some examples of doublets are: the 2012 Emilia-Romagna sequence (Italy), during which a magnitude 5.9 event occurred on May 20th, followed by a magnitude 5.8 event on May 29th; the 1992 Landers earthquake in California, which has been associated to the Big Bear earthquake, that hit about three hours later after the mainshock; the 2006 November 15th M8.3 event along the Kuril arc followed by a M8.1 event on 13 January 2007 is one of the largest great doublet earthquake on record.

The spatial distribution of aftershocks usually well correlates with the coseismic (static) Coulomb stress change, while the observed time delay of aftershocks, as well as their diffusive-like behavior, have been explained as due to additional physical processes such as post-seismic relaxation, afterslip, poro-elastic effect, as well as induced fluid propagation.

In this work we first perform an analysis of the available worldwide seismic catalogs in order to identify a number of doublet earthquakes based on a spatial and temporal distance correlation. Then we perform a parametric study to identify the main characteristics of every couple of events and extrapolate the common relations between time delay, hypocentral distances, geological, as well as hydrogeological parameters and fluids content. Numerical simulations are then carried out to study the time delay occurring between two events as related to hydrogeological and hydromechanical parameters.