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EXTENDED ABSTRACT

Mechanical Interaction among Large Earthquakes in Eastern part of Iran

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1. Introduction

Human being has been faced with destructive phenomenon specially earthquake for a long time. Knowing about the time and area of major earthquake and aftershocks is so necessary to mitigate the damage of financial and life by warning the earthquake or aftershocks happen before it really happened. Maybe this day we can't predict the earthquake exactly but the study about the information of previous earthquakes can identify the potential land that have Earthquake Bloodbath and with this knowing in building construction we can mitigate the damage due to the earthquake.

The tendency of rocks to fail in a brittle manner is thought to be a function of both shear and confining stresses, commonly formulated as the Coulomb failure criterion. Here we explore how changes in Coulomb conditions associated with one or more earthquakes may trigger subsequent events.

Study of Stress changes in earth's crust is useful for the predicting earthquakes. Analysis of Coulomb stress changes has been used in many seismic areas. These researches showed that the area and the speed of next earthquake will affect by the static stress changes which are the result of historical earthquake in this area.

2. Coulomb Failure Criterion

Knowing the time and place of major earthquakes is essential to warn. Analysis of Coulomb Stress Changes at moderate seismic depth has been used to estimate the probability of an earthquake in many seismic regions of the world. These studies show that in most cases the location of subsequent earthquakes is affected by changes in the Coulomb Stress caused by previous earthquakes in that region. In this study, in order to investigate the possible location of large earthquakes, Coulomb Stress Changes of 24 historical and instrumental earthquake with magnitudes greater than 5.5 in East Iran calculated in historical order. The study of mechanical interaction among earthquakes shows the spatial relationship for about 50% of events. In order to know about the areas that have highest probability, we compute the cumulative Coulomb Stress Change caused by the coseismic deformation of earthquakes on strike-slip and dip-slip faults with optimal geometry. Results of these estimations showed that the high-risk areas for causing the next large earthquakes were areas that are in the region of Columbus Stress Change increase due to previous earthquakes and have active faults in the direction of optimal strike-slip and dip-slip fractures.

Various criteria have been used to characterize the conditions under which failure coours in rocks. One of the more widely used is the Coulomb failure criterion, which requires that both the shear and normal stress on

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an incipient fault plane satisfy conditions analogues to those of friction on a preexisting surface. In Coulomb criterion, failure occurs on a plane when the Coulomb stress exceeds a specific value. Our modeling is most sensitive to the regional stress direction, modestly sensitive to the coefficient of effective friction, and insensitive to the regional stress amplitude.

3. Estimation of mechanical interaction among large earthquakes in the eastern part of Iran

In order to investigate the possible location of large earthquakes, Coulomb Stress Changes of 24 historical and instrumental earthquake with magnitudes greater than 5.5 in East Iran calculated in historical order.

In order to know the parameters describing the fault planes of historical earthquakes, the main possible faults were first attributed to historical events.

Then the azimuth of historical earthquakes were obtained by measuring the direction angle of the probable main fault from the map of active faults in Iran (Hessami et al., 2003).

The slope angle of historical earthquakes was inferred based on the type of main fault using Anderson theory of faulting, and the rake angle of historical events were determined based on the type of the main fault, using the angles proposed by Aki and Richards (2002).

Parameters of fault planes of instrumental earthquakes before 1976, from the basic parameters of Iranian earthquakes prepared by Mirzaei et al., (1997) and also from the parameters collected by Jackson et al., (1995) and from 1976 up to now extracted from CMT.

The Wells and Coppersmith (1994) empirical relationships between the magnitude of the earthquake and the geometric parameters of the rupture were used to calculate the length, width and amount of slip due to an earthquake.

According to research, the magnitude of the regional stress has no effect on how the Columbus stress is distributed and only the direction of the regional stress changes the orientation of the planes ready for failure (King et al., 1994). Therefore, in modeling the Coulomb stress changes on faults with optimal geometry, it is only necessary to define the direction of regional stress in the study area. Therefore, the main components of the regional stress tensor were extracted from the research of Zarifi et al., (2013) throughout Iran.

The study of mechanical interaction among earthquakes shows the spatial relationship for about 50% of events. For example the Great Earthquake of 1947 increased stress at the end of the Dashte-Bayaz fault, causing a devastating earthquake in late August 1968 (Fig. 1-a). A few days later, in September 1968, another earthquake occurred west of the rupture plane of the first event, due to the excitation of this earthquake near the Ferdows fault (Fig. 1-b).

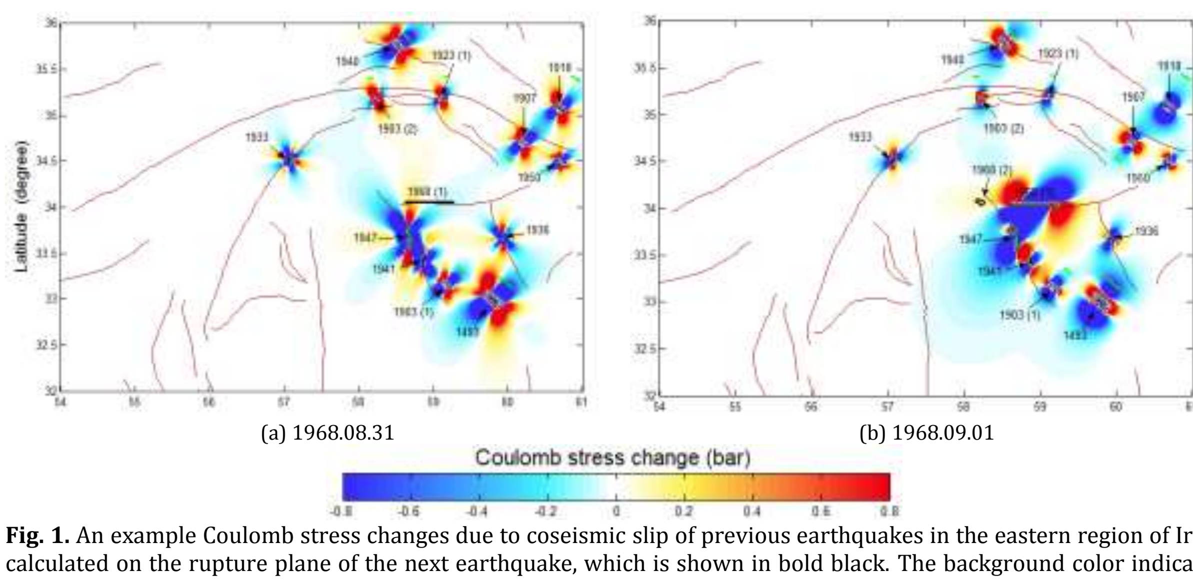
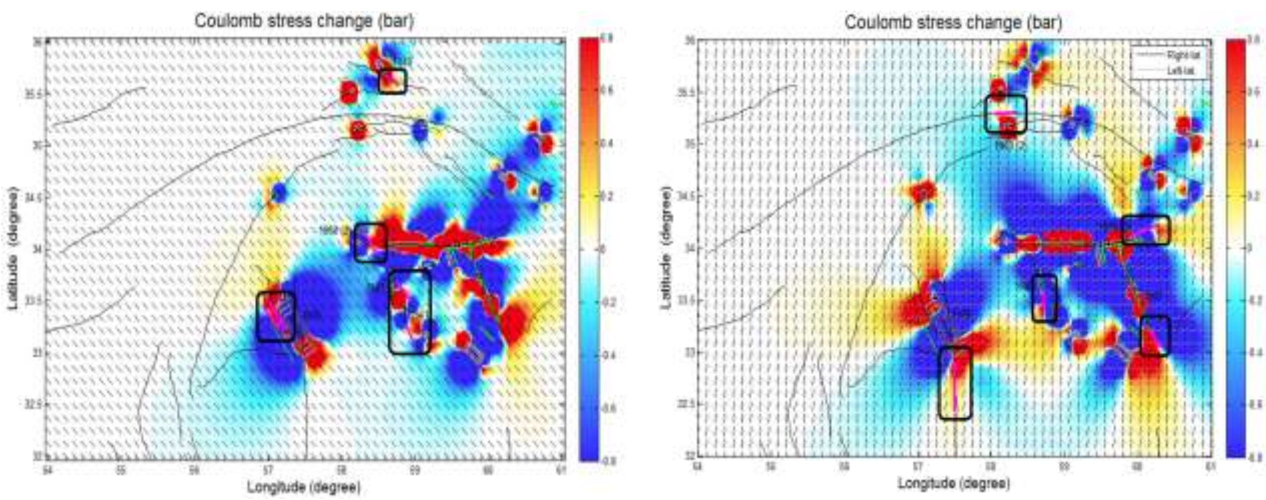


Fig. 1. An example Coulomb stress changes due to coseismic slip of previous earthquakes in the eastern region of Iran, calculated on the rupture plane of the next earthquake, which is shown in bold black. The background color indicates the change in Coulomb stress in bar, which is calculated cumulatively. In each figure, the surface effect of each earthquake is shown in green.

Fig. 2-a shows the Coulomb Stress Changes for reverse faults with optimal geometry. According to this figure, the high-risk and probable areas for large earthquakes are areas where the active fault is in the area of increasing Columbus Stress of previous earthquakes, in the direction of the optimal directions of the reverse faults. The faults in the area that are ready to rupture and are shown in pink are: 1- Part of Balher fault in the southwest of 1940 earthquake rupture plane, 2- The northern part of Ferdows reverse fault in the west of the rupture plane of the second earthquake of 1968 and the southern part of the Ferdows reverse fault in the west of the rupture plane of the 1947 earthquake, 3- Part of Mohammadabad reverse fault in the south of the 1941 earthquake rupture plane, 4- Parts of Tabas reverse fault plane in the east of the 1978 earthquake rupture plane.

Fig. 2-b shows the Coulomb Stress Changes for strike-slip faults with optimal geometry. According to this figure, high-risk and probable areas for large earthquakes are areas where in the region of Columbus Stress increase of previous earthquakes, active faults are present in the direction of the optimal directions of strike-slip faults. The faults in the area that are ready to rupture and are shown in pink are: 1- Part of the Doruneh strike slip fault in the north of the second earthquake plane of 1903, 2- The western part of the Dashte-Bayaz strike slip fault in the west of the third earthquake plane of the 1979 earthquake, 3- Dostoobad strike-slip fault in the South of the 1947 earthquake rupture plane, 4- The end part of the Abiz strike-slip fault in the south of the 1997 Neyband earthquake fault plane.



(a) (b)

Fig. 2. Coulomb stress changes calculated on faults with optimal geometry: a) dip-slip, b) strike-slip. The background color indicates the Columbus stress changes in terms of bar. The faults that cause the Columbus stress changes are shown in green, the active faults in the region are shown in black, and the faults that are ready to rupture and create earthquakes are shown in pink inside the black rectangle.

4. Conclusions

In order to investigate the possibile locations earthquakes, we compute cumulative co-seismic coulomb stress changes of 24 historical and instrumental earthquakes with magnitude (M>5.5) in East Iran after each earthquake, using the component of stress associated with the fault orientation and slip direction of the next event. The results of the earthquake interactions, show falling before or after of the next happening.

Also in order to knowing about the area that has highest probability, we compute the cumulative coulomb stress change caused by the coseismic deformation of historical and instrumental earthquakes on strike-silp and reverse fault planes with optimum geometry. The results show that the hazard areas that have the potential for next earthquakes, be the areas in the realm of increase coseismic coulomb stress of previous earthquakes, an active fault was in direct with the optimum directions of strike-slip faults and reverse faults.

5. References

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