Does the Spatial Analysis of 2012 Ahar-Varzeghan Seismic Sequence Corrobore the Tectonic Interpretations?

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Introduction To The Sequence

On 11 August 2012, two destructive shallow earthquakes Mw=6.4 and Mw=6.2 occurred within distance of about 6 km and time lag of 11 minutes, in Northwestern Iran between the small cities of Ahar and Varzeghan with no previously well known active fault or significant seismicity. The following aftershock sequence remained strongly active during four months with more than 3500 events registered by the Iranian Seismological Center in an area within a radius of 50 km. The magnitude distribution of the sequence gives a b-value of 0.97 for cutoff magnitude Mw=2.0.

4m observed surface rupture which starts at a 4 km west of the first mainshock continues about 8 km westward.

Re-Localization Of The Sequence

The seismicity since August 2012 to the end of November 2012 has been re-localized using double difference algorithm of Waldhauser and Ellsworth (2000). The maximum distance of 200 km was considered between a pair and station and maximum distance of 15 km for each pair of events. The principal cluster has over 600 events with centroid at ~ 38.42N, ~46.74E and ~13.40 km depth. For the velocity model the result of study by Donner et al(2015) was used. (7 layers and Vp/Vs ratio 1.7)

CFS Changes Due To The Doublet

Regional stress: looking at the regional stress map if we consider a mean angle of 135° for maximum horizontal stress in the area on the and assume an approximately zero plunge then the optimum strike slip faulting will be on vertical planes that have angle of 5°(28°) with the maximum horizontal stress. It means an angle of 169° for left lateral and 101° for a right lateral planes for μ=0.4.

Coulomb Failure Stress Changes: For strike, dip and rake of 101.90 and 180 the change of CFS due to both mainshocks and for frictional coefficient 0.4 and 0.6 for the strike slip and strike slip with inverse components respectively were calculated. The main focus was on depths between 11 to 17 km and the result shows high density of the events on the positive stress change areas. The CFS changes for optimum rives and normal planes was also calculated.

Conclusions

Based on our knowledge from previous works investigating the mechanism of the faulting for the doublet of Ahar-Varzeghan, we tried to find the best explanation using the changes in the coulomb failure stress and the aforesaid sequence spatial distribution in different depths. The results for the assumption of North-South orientation plane for the second mainshock at lower depth in respect to the first shock’s fault, was presented in this study. This assumption made us to be able to justify the spatial distribution of the sequence coming during 4 months and improve our understanding about the source. The agreement between the spatial distribute of more than 500 relocated data at the mean depth of 14 km with the CFS changes for optimum strike slip faulting (as the most probable regional mechanism) leads us to accept that the doublet most likely occurred on a perpendicular structure and corroborate with the result of previous studies.

Doublet’s Fault Geometry

East West parallel planes ?

Not in good agreement with rock mechanical perspective since they have almost the same size.

The rupture orientation and focal mechanism of the second shock do not agree

CFS Changes Due To The First Mainshock

The coulomb stress change because of the first mainshock was studied in order to see if it has triggered the second mainshock. Considering the epicenter given by Donner et al. 2015 and with the mentioned geometry for the first mainshock, it is more likely that the second shock had happened at a hypocentral depth lower than the edge of the first fault. Using a smoothed elliptical source model the slip was weighted over the fault plane considering the released energy. A fiction coefficient of 0.4 was considered since the faulting is strike slip.

References

B. Donner et al. 2015, “The Ahar-Varzeghan Earthquake Doublet (Mw 6.4 and 6.2) of 11 August 2012: Regional Seismic Moment Tensors and A Seismotectonic Interpretation”, BSSA, Vol. 105, No. 2a

References

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