

## Two source faults of Ahar-Varzaghan Earthquakes, August 11, 2012, NW- Iran

دو گسل مسبب زمینلرزه های اهر – ورزقان، ۲۱ مرداد ۱۳۹۱، شمال غرب ایران

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### Abstract

In this study, I proposed the causative faults of Ahar-Varzaghan double earthquakes, August 11, 2012 (mb 6.2 and 6.0). Epicentral distribution of 300 aftershocks located by Iranian seismological center during four days after the main events, show a nearly E-W trend which is compatible well with one of the nodal planes of focal mechanisms of each related main shocks. Two preexisting linearity in the region which covered by the aftershocks distribution were good reason to assume them as the two causative faults. The strike of these faults has a good coincidence with the strike of the nodal planes obtained by the fault plane solutions of Harvard University. Also, the dip angle of the fault planes and the hypocentral locations of the main shocks both confirm the right surface trace of the seismic faults of Ahar – Varzaghan earthquakes.

### چکیده

در این تحقیق، گسل های مسبب زوج زمینلرزه های اهر – ورزقان، ۲۱ مرداد ۱۳۹۱، با بزرگای ۶/۲ و ۶/۰ در مقیاس امواج درونی زمین را معرفی نموده ایم. توزیع کانون های سطحی ۳۰۰ پس لرزه که توسط مرکز لرزه نگاری کشوری در طول چهار روز اول پس از زلزله های اصلی ثبت شده اند، نشان دهنده یک راستای تقریبی شرقی – غربی می باشد که با امتداد صفحات گرهی حاصل از حل مکانیزم کانونی هر یک از زلزله ها همخوانی خوبی را نشان می دهد. حضور دو خط واره از قبل موجود در منطقه که با توزیع کانون های سطحی پس لرزه ها پوشیده می شوند، می تواند دلیل خوبی برای در نظر گرفتن آنها بعنوان گسل های مسبب این دو زمینلرزه باشد. امتداد هر یک از این دو گسل تطابق خوبی با امتداد صفحات گرهی معرفی شده توسط دانشگاه هاروارد نیز نشان می دهد. همچنین، مقادیر زوایای شیب صفحات گسلی و موقعیت های کانون عمقی زلزله های اصلی، تایید کننده موقعیت صحیح اثر سطحی گسل های مسبب زمینلرزه های اهر – ورزقان می باشند.

## Proposed seismic faults

Two relatively large shallow earthquakes struck NW- Iran, about 60 and 50 km northwest of Tabriz city, on August 11, 2012. It caused about 306 dead and 3037 wounded people (Press TV, reported from the health minister of Iran). The first earthquake (mb 6.2) occurred at 16:53 in local time and the second one (mb 6.0) happened with about 11 minutes later (Tables 1 & 2).

Table 1: Earthquake reports by different agencies for the first quake. IRSC: Iranian Seismological Center, IIEES: International Institute of Earthquake Engineering and Seismology, USGS: U.S. Geological Survey.  
(For local time of the events you may add +04:30:00 to UTC time)

Ref.	UTC time	Lat.	Long.	Mag. type	Mag.	Depth
IRSC	12:23:15.3	38.495	46.865	Mn	6.2	10
IIEES	12:23:16.2	38.55	46.87	mb	6.1	15
USGS	12:23:17.0	38.322	46.888	Mw	6.4	9.9

Table 2: Earthquake reports by different agencies for the second quake. IRSC: Iranian Seismological Center, IIEES: International Institute of Earthquake Engineering and Seismology, USGS: U.S. Geological Survey.  
(For local time of the events you may add +04:30:00 to UTC time)

Ref.	UTC time	Lat.	Long.	Mag. type	Mag.	Depth
IRSC	12:34:34.8	38.449	46.731	Mn	6.0	10
IIEES	12:34:35.0	38.58	46.78	mb	6.1	16
USGS	12:34:35	38.324	46.759	Mw	6.3	9.8

To determine the trace of the seismic faults in the region, 300 aftershocks located by Iranian seismological center during August 11 to 14, were overlaid on satellite imagery. The epicentral locations of the main shocks and aftershocks distribution (IRSC bulletin) (Fig.1) show that, the recent large earthquake in Iran, Ahar-Varzaghan earthquake, may have other source(s) than Tabriz and Ahar faults which are two main active faults in NW-Iran. The strike of the earthquake fault(s) seems to be nearly E-W in contrast of NW-SE strike of Tabriz and Ahar faults. Using satellite images I found two lineaments that fell inside of the aftershock region and also their strike surprisingly had a good coincidence with the trend of them. The double earthquakes occurred by activation of two nearly parallel faults (No. 1 and 2 in fig.1). The fault plane solutions of these earthquakes

(GCMT catalogue), have a good compatibility with the location of hypocenters and the strike of proposed seismic faults (Table 3).

Table 3: The source parameters obtain by the fault plane solutions of the two events (Harvard GCMT) and the results of this study.

Parameters	GCMT1	Proposed Fault1	GCMT2	Proposed Fault2
Strike	82	87	256	261
Dip	89	-	67	-
Slip	164	-	135	-
Length (km)	-	26	-	28

The location of the first event may be incorrect due to its uncertainty and should move about 3.5 km toward south to match well with its mechanism and the position of fault trace 1. The mechanism of the first event shows a right lateral strike slip faulting while for the second one the reverse motion component is dominant. Considering the tectonics of the region, we may conclude that these two faults are branches of a main strike slip fault at the depth of more than 10 km (Positive flower structure). Sattar-Khan Dam, one of a main structure in earthquake region is in the way of fault trace 1. The axes of this dam have only about 1.3 km distance southward from the fault 1 which is passed through its lake (Fig. 2).

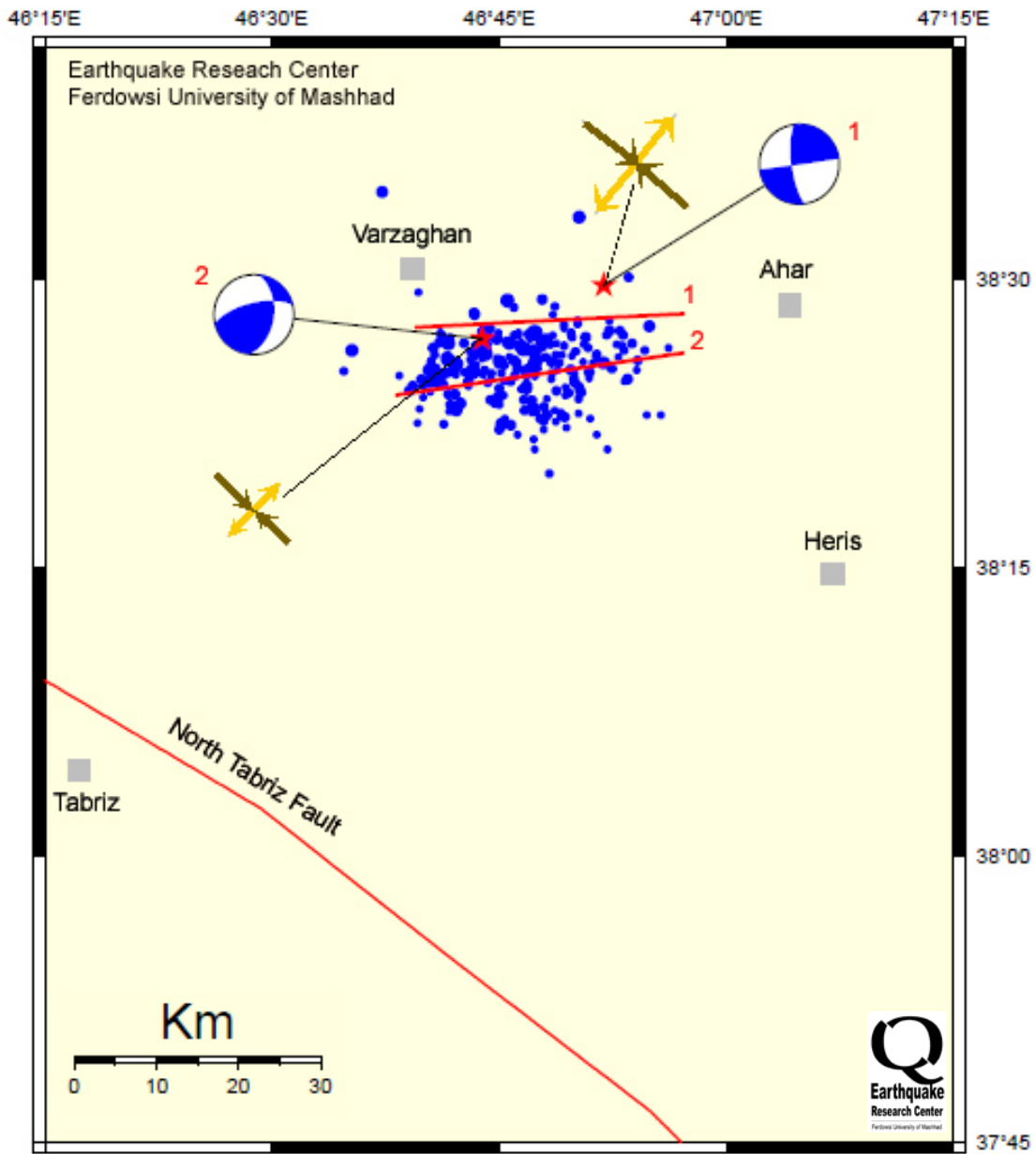


Figure 1: Distribution of 300 aftershocks of Ahar - Varzaghan double earthquakes. Numbers 1 & 2 refers to the causative earthquake faults and their mechanisms. Red stars show the epicenters of main shocks located by IRSC (Iranian Seismological Center). Also the P and T axes of each earthquake are shown.



Figure2: Satellite image (Google maps, 2012) of study area overlaid by the proposed causative faults of Ahar – Varzaghan earthquakes (red lines) and the location of some important cities (large rectangle) and villages (small rectangles). The location of Sattarkhan Dam is shown by a triangle around the center of the image and about 1.3 km south of fault 1.

## References

Global Centroid Moment Tensor catalogue (GCMT), <http://www.globalcmt.org/CMTsearch.html>

Google maps, <http://maps.google.com/>

Iranian Seismological Center (IRSC) bulletin, <http://irsc.ut.ac.ir/bulletin.php?lang=fa>

Press TV, [www.presstv.ir/detail/.../death-toll-from-iran-quakes-rises-to-306/](http://www.presstv.ir/detail/.../death-toll-from-iran-quakes-rises-to-306/), 13 August 2012.