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Technical Note

CHARACTERISTICS OF THE STRONG GROUND MOTION DATA RECORDED IN IRAN FOR THE YEAR 2010

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ABSTRACT

During this year, 329 accelerograms were recorded by 196 accelerographs, which were triggered by 176 earthquakes with different magnitudes. The Reygan earthquake of 20th December 2010 in Kerman province was the greatest earthquake in this year that triggered 24 accelerographs. The maximum PGA of about 0.61g was recorded in Koohezar station on August 27, 2010 earthquake.

Keywords: Accelerogram; accelerograph; earthquake; strong motion; peak ground acceleration

1. INTRODUCTION

The Iran Strong Motion Network (ISMN) started its activities in 1973. The network was consisted of 274 accelerographs until 1992. At the date of this study, the network has 1150 accelerographic stations (Figure 1) that are equipped with digital SSA-2 or CMG.5T system. The trigger level of all the instruments were set at 0.01g and more than 8000 three component accelerograms have been recorded since then. The recorded accelerograms are downloaded, controlled, processed and finally added to the Iranian earthquake comprehensive data bank, which is accessible for the experts, who works in the field of engineering seismology and earthquake engineering. In this article, the most important earthquakes are described in brief.

2. IMPORTANT STRONG GROUND MOTION DATA, IN 2010

During this year, 329 accelerograms were recorded by 196 accelerographs, which were triggered by 176 earthquakes with different magnitude (Figures 1 and 2).

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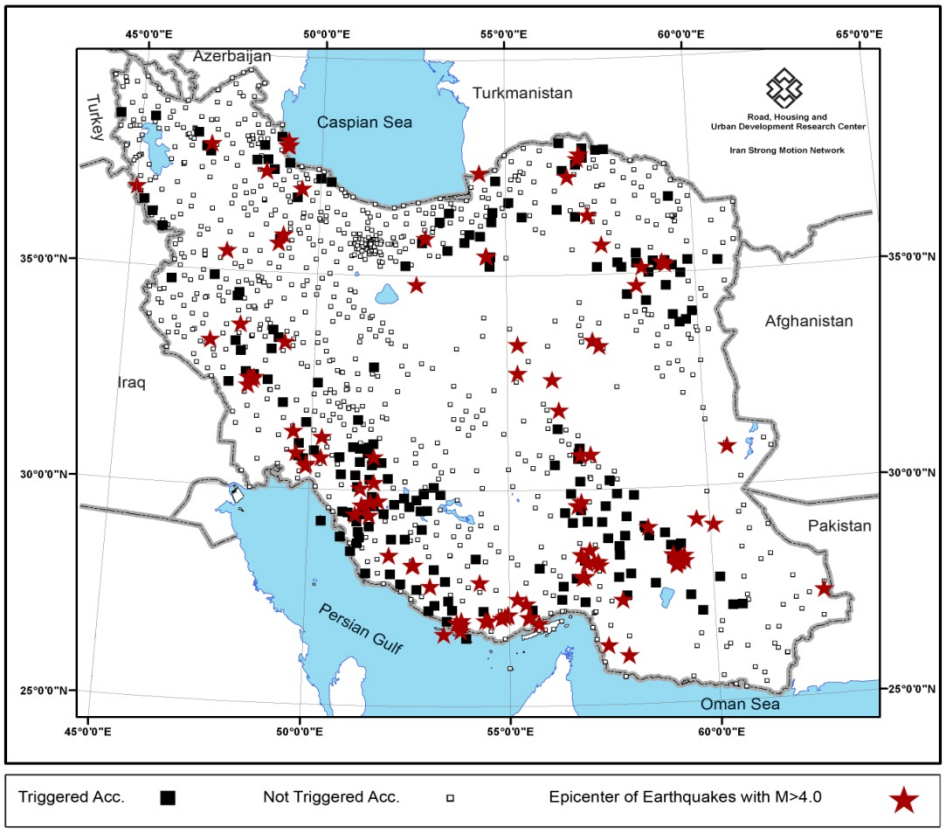

Figure 1. The location map of the triggered accelerographs and the epicenter of the most important earthquakes occurred in 2010

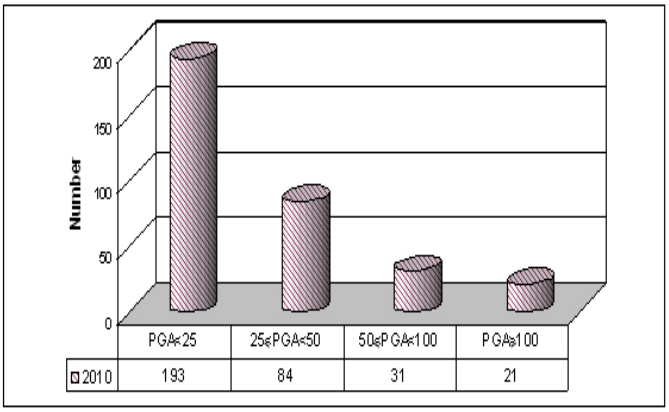

Figure 2. Peak ground accelerations recorded in 2010

The trigger levels of all accelerographs are set on 0.01g. The Reygan earthquake of 20th December 2010 in Kerman province was the greatest earthquake in this year that triggered 24 accelerographs. While, the maximum PGA of about 0.61g 0.606g was recorded in

Koohezar station because of the earthquake of August 27, 2010 In this article the most important earthquakes and those with more than three accelerograms in the studied time period are discussed in brief and the detailed information is presented in the final table.

2.1 Hosseiniyeh Olya Earthquake of February 23rd ,2010

About 3 hours after foreshock of Hosseiniyeh Olya earthquake, at 10:25:54 (UTC), the main shock, with Mw5.4 (BHRC), occurred in a region between Andimeshk and Hosseiniyeh Olya, which was recorded in Hosseiniyeh Olya, Andimeshk, Dasht-e-Abbas and Dez Dam accelerograph stations (Figure 3). The uncorrected peak ground acceleration of this event was recorded in Hosseiniyeh Olya station that is presented in Table 1 along with other motion parameters.

Table 1. The ground motion parameters of Hosseiniyeh Olya accelerogram

Station: Hosseiniyeh Olya	N Record: 4942/01	ts-tp: 2.34 s	Vs30: 750m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	196	64	299
PGV (Cm/s)	4.8	1.24	10.35
PGD (cm)	0.138	0.138	0.887
Duration (second)	5.46	7.33	2.97
Sensor direction (degrees)	0	-	90

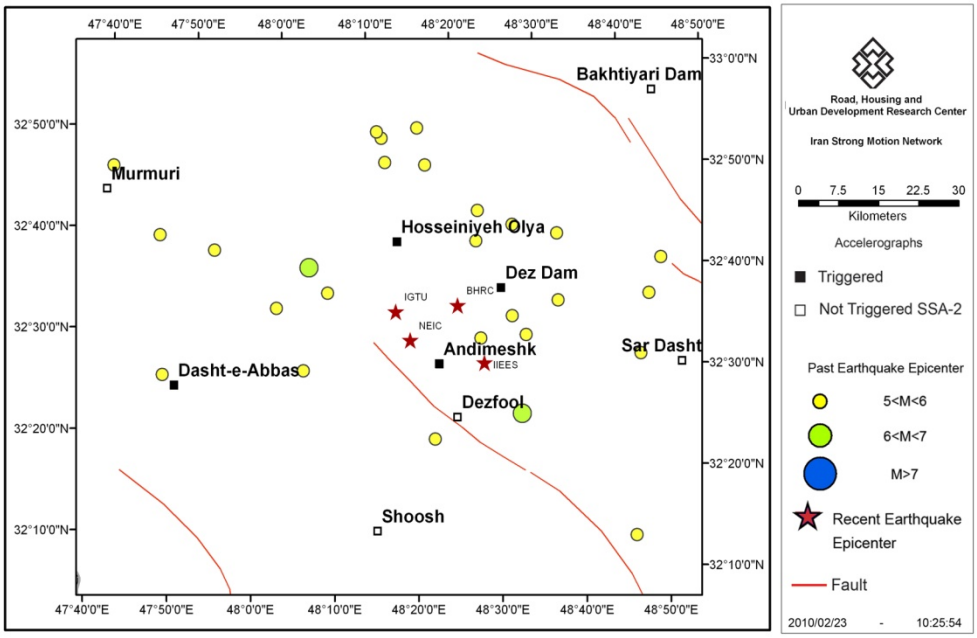

Figure 3. The epicenter location and the distribution of accelerograph stations in the region of Hosseiniyeh Olya Earthquake

2.2 Konar Takhteh Earthquake of May 14th, 2010

On May 14th 2010 at 18:49:56 (UTC), an earthquake with Mw5.1 (BHRC), Mn5.1 (IGTU)

occurred in South of Konar Takhteh city in Fars province. This event was recorded in Konar Takhteh, Dalaki, Kazeroon, Saed Abad, Borazjan, Tange Eram, Narges Zar and Shabankareh accelerograph stations (Figure 4). The uncorrected peak acceleration was recorded in Konar Takhteh station that is presented in Table 2 along with other motion parameters.

Table 2. The ground motion parameters of Konar Takhteh accelerogram

Station: Konar Takhteh	N Record: 4958	ts-tp:3.5 s	Vs30: 450m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	135	97	121
PGV (Cm/s)	4.62	1.75	7.36
PGD (cm)	0.298	0.081	0.51
Duration (second)	10.47	8.28	9.57
Sensor direction (degrees)	278	-	8

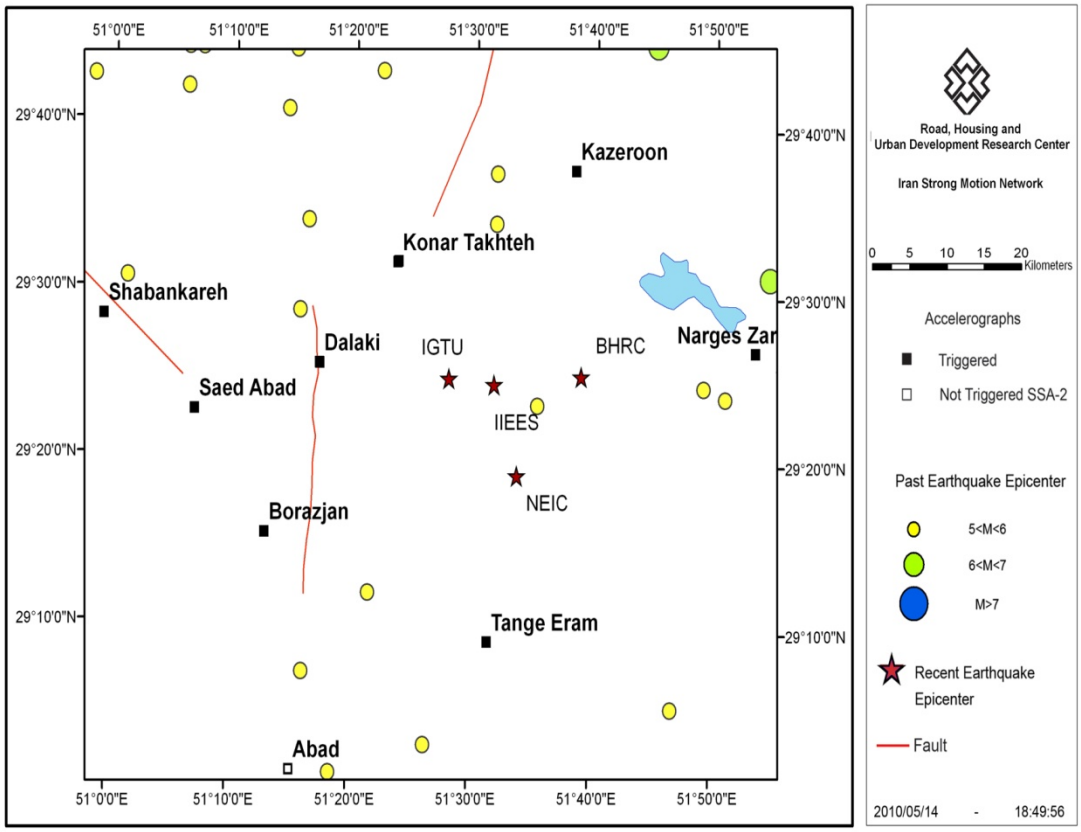

Figure 4. The epicenter location and the distribution of accelerograph stations in the region of Konar Takhteh Earthquake

2.7 Eshkanan Earthquake of July 20th, 2010

Border area between Boushehr and Fars provinces of Iran struck on July 20th, 2010 at

19:38:10 (UTC) because of an earthquake with Mw5.9 (BHRC), Mn5.8 (IGUT). This event was recorded in Eshkanan, Rostagh, Bandare-e-Moqam, Beyram, Lamerd, Bastak, Bahrestan and Kish accelerograph stations (Figureure 5). The maximum uncorrected peak acceleration, which presented in Table 3 along with other ground motion parameters, was recorded in Eshkanan station.

Table 3. The ground motion parameters of Eshkanan accelerogram

Station: Eshkanan	N Record: 4994/01	ts-tp:4.61 s	Vs30: 1066 m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	251	104	338
PGV (Cm/s)	4.06	2.14	4.96
PGD (cm)	0.423	0.355	0.345
Duration (second)	6.59	11.87	6.47
Sensor direction (degrees)	0	-	90

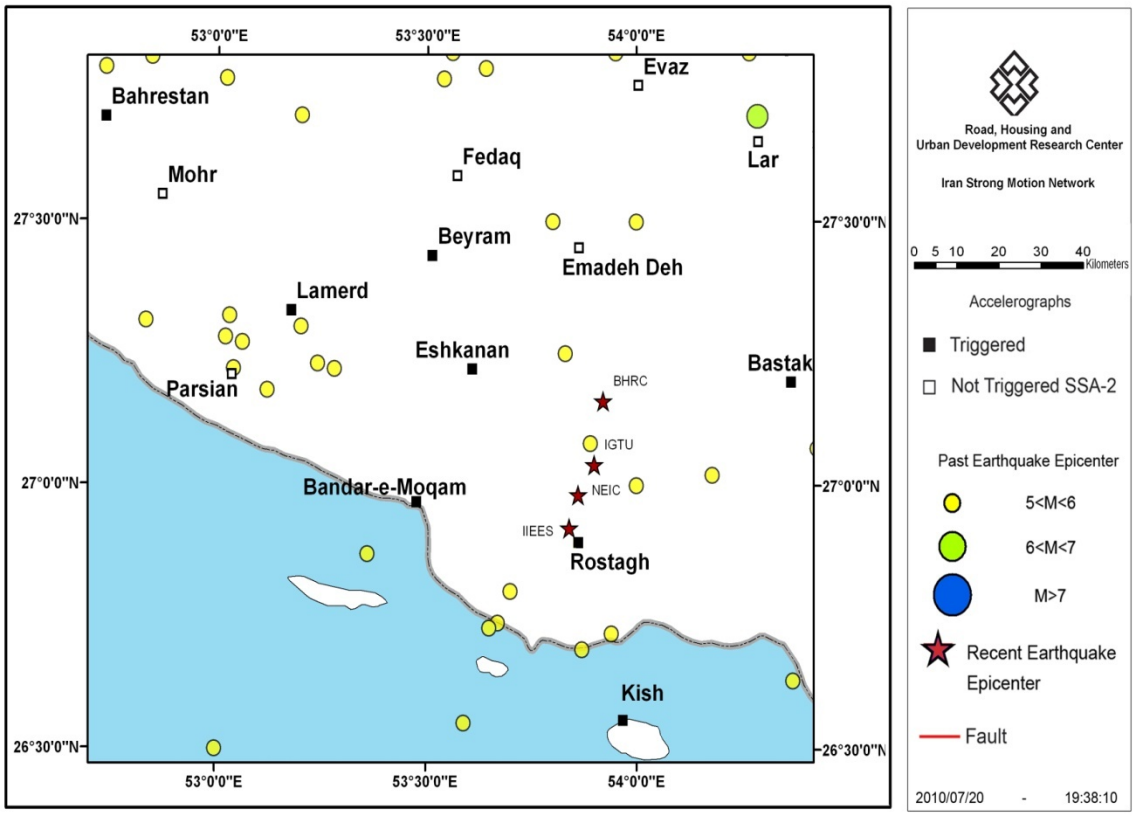

Figure 5. The epicentre location and the distribution of accelerograph stations in the region of Eshkanan Earthquake

2.10 Torbate Heiydaryeh Earthquake of July 30th, 2010

On the 30th of July, 2010 at 13:50:14 (UTC), a relatively strong earthquake with the magnitude of Mw5.9 (BHRC), Mn5.7 (IGUT) occurred near Torbate Heiydaryeh city in

Khorasan Razavi province in Iran. This event was recorded by 21 sets of digital accelerographs of Iran Strong Motion Network (ISMN) (Figure 6). The maximum uncorrected peak acceleration of about 434 cm/s/s was recorded in Torbat Heiydariyeh station (Table 4). The reported damages of this event were negligible.

Table 4. The ground motion parameters of Torbat Heiydariyeh accelerogram

Station: Torbat Heidariyeh	N Record: 5006	ts-tp:2.35 s	Vs30:306m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	426	118	170
PGV (Cm/s)	19.32	4.12	7.45
PGD (cm)	1.94	0.29	0.63
Duration (second)	4.5	8.01	8.68
Sensor direction (degrees)	192	-	282

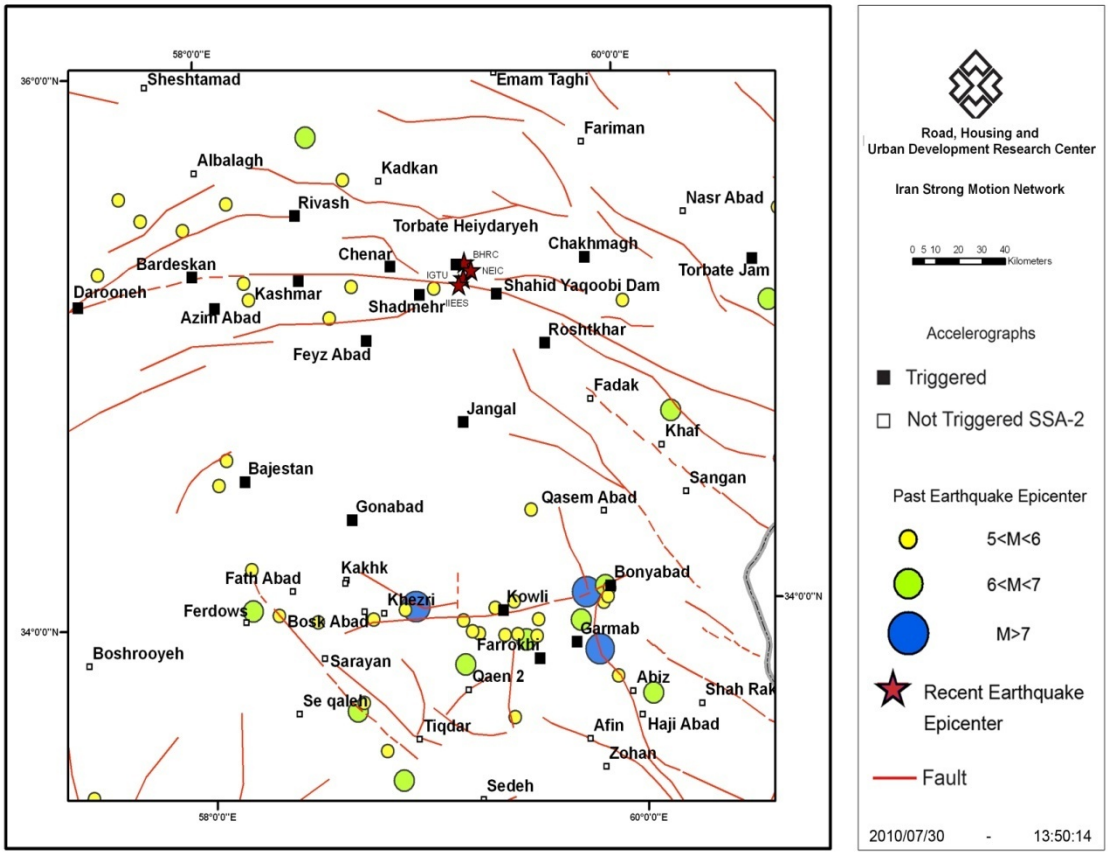

Figure 6. The epicenter location and the distribution of accelerograph stations in the region of Torbat Heidariyeh Earthquake

2.11 Laleh Zar Earthquake of July 31st, 2010

On July 31st, 2010 at 06:52:56 (UTC), an earthquake with magnitude of Mw5.7 (BHRC), Mn5.8 (IGUT) occurred in the northeast of Laleh Zar city in Kerman Province, South-East of

Iran. This event was recorded by 9 sets of digital accelerographs of Iran Strong Motion Network (Figure 7). The maximum peak ground acceleration of this event was recorded in Laleh Zar station (Table 5).

Table 5. The ground motion parameters of Laleh Zar accelerogram

Station: Laleh Zar	N Record: 5014	ts-tp:2.21s	Vs30: 678m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	78	61	112
PGV (Cm/s)	6.65	2.40	6.90
PGD (cm)	0.79	0.27	0.70
Duration (second)	5.38	7.26	4.46
Sensor direction (degrees)	65	-	155

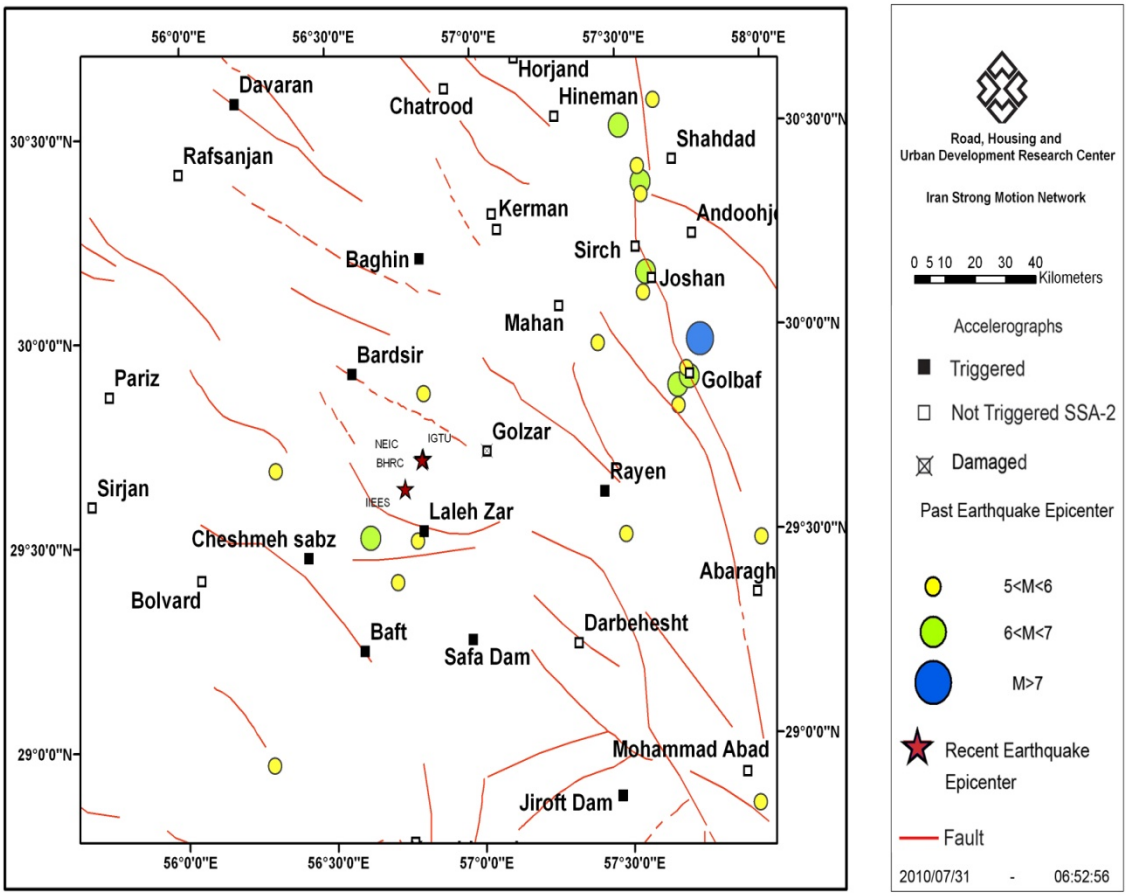

Figure 7. The epicenter location and the distribution of accelerograph stations in the region of Laleh Zar Earthquake

2.14 Kooh-e-Zar Earthquake of August 27th,

On August 27th, 2010 at 19:23:48 (UTC) a moderate earthquake with Mw5.6 (BHRC), Mn5.9 (IGUT) occurred in the east of Kooh-e-Zar village in Semnan Province. This event

was recorded by 9 sets of digital accelerographs of Iran Strong Ground Motion Network (Figure 8). The maximum PGA of this event has been recorded in Kooh-e-Zar station, which is presented in Table 6, along with other calculated ground motion parameters.

Table 6. The ground motion parameters of kooh-e-zar accelerogram

Station: Kooh-e-zar	N Record: 5030/01	ts-tp:1.76s	Vs30: 759 m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	473	416	606
PGV (Cm/s)	19.79	8.43	39.40
PGD (cm)	2.73	0.69	7.63
Duration (second)	3.88	5.64	3.15
Sensor direction (degrees)	135	-	225

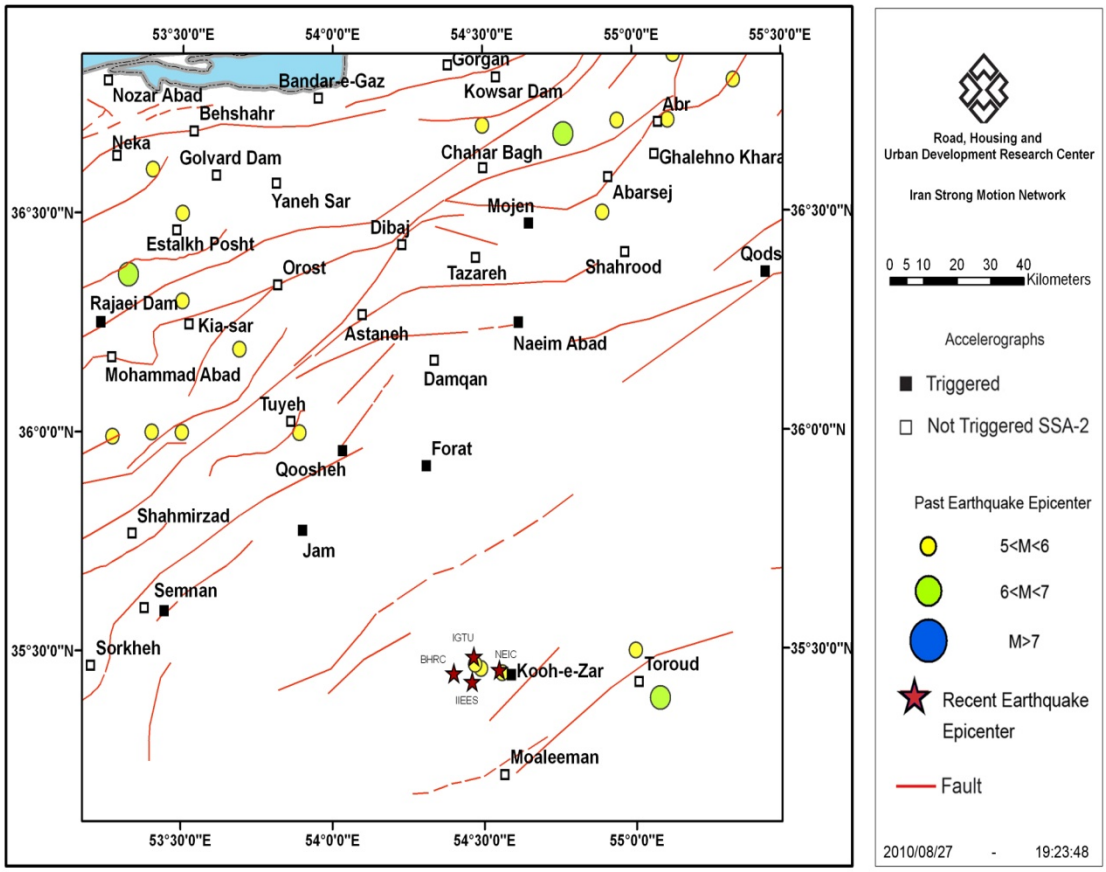

Figure 8. The epicenter location and the distribution of accelerograph stations in the region of Kooh-e-zar Earthquake

2.16 Ghaemiyeh Earthquake of September 27th, 2010

On September 27th, 2010 at 11:22:46 UTC an earthquake with magnitude of Mw5.8 (BHRC), Mn6.1 (IGTU) occurred in Fars Province. This event was recorded by 28 sets of accelerographs stations of ISMN (Figure 9). The maximum peak ground acceleration of this

event has been recorded in Ghaemiyeh station (Table 7). BHRC estimated the epicenter on 29.78N, 51.76E and the magnitude of this event to be Mw5.8 and Ml6.1 using the recorded strong motion data.

Table 7. The ground motion parameters of Ghaemiyeh accelerogram

Station: Ghaemiyeh	N Record: 5062	ts-tp:3.34s	Vs30: 617m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	320	100	328
PGV (Cm/s)	18.79	2.81	12.04
PGD (cm)	1.70	0.21	1.35
Duration (second)	4.01	11.15	6.5
Sensor direction (degrees)	0	-	90

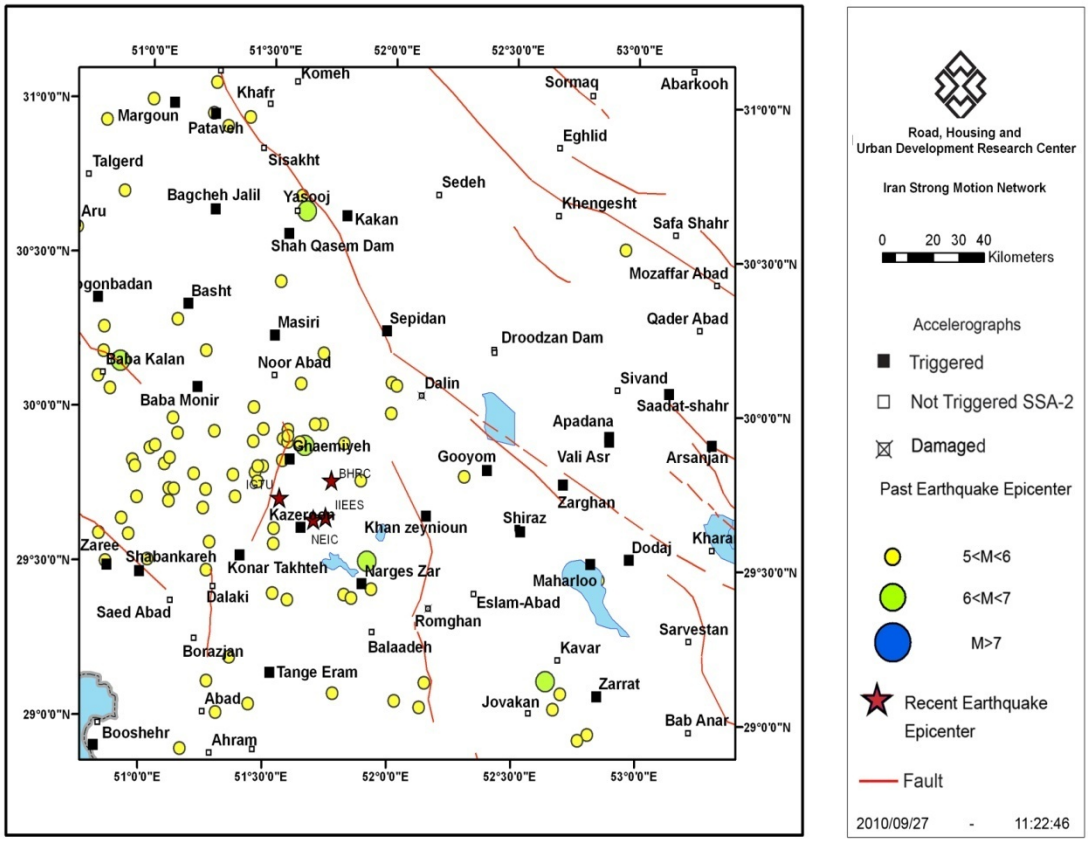

Figure 9. The epicenter location and the distribution of accelerograph stations in the region of Ghaemiyeh Earthquake

2.19 Reygan Earthquake of December 20th, 2010

On December 20th, 2010 at 18:41:59 (UTC), a relatively strong earthquake with Mw6.5 (BHRC), Mn6.5 (IGUT) occurred in the south east Reygan of town, in the South of Kerman Province. This event was recorded by 24 sets of digital accelerographs of Iran Strong ~~Ground~~ Motion Network (Figure10). The maximum peak ground acceleration of this event

was recorded in Reygan station (Table 8) and its' epicenter estimated to be on 28.32N, 59.19E using the recorded accelerograms (BHRC).

Table 8. The ground motion parameters of Reygan accelerogram

Station: Reygan	N Record: 5130	ts-tp:5.9 s	Vs30: 437 m/s
Parameters	Components		
	L	V	T
PGA (Cm/s/s)	57	45	123
PGV (Cm/s)	6.04	3.29	6.30
PGD (cm)	3.09	1.29	2.2
Duration (second)	20.45	29.04	19.5
Sensor direction (degrees)	10	-	100

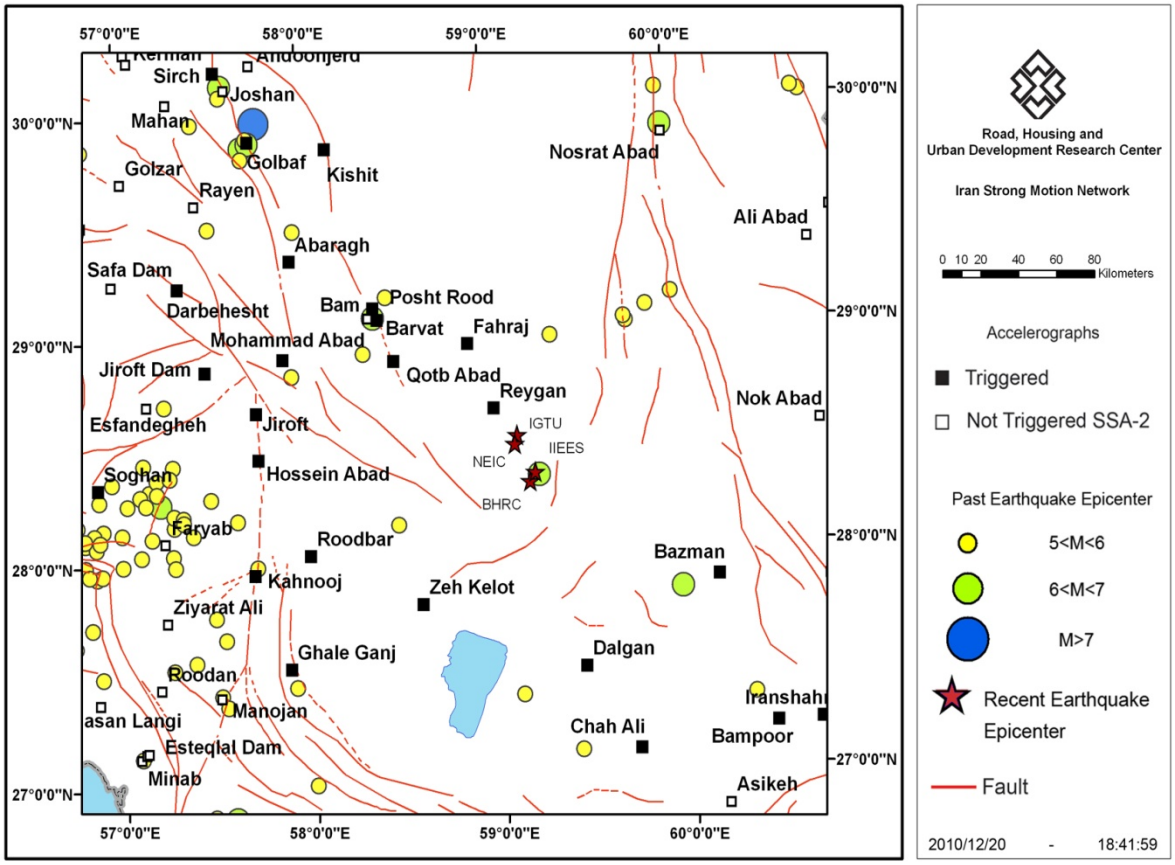

Figure 10. The epicenter location and the distribution of accelerograph stations in the region of Reygan Earthquake

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5. European Mediterranean seismological center,(www.emsc-csem.org).

Appendix: Table

The characteristic of accelerogram with PGA more than 0.05 Cm/s/s

Station	Record No.	Coordinate		U.P.G.A (cm/s/s)	Origin time		Epicenter		M	Ref.
		N	E		M/D/Y	h:m:s	N	E		
Kahoorestan	4936/01	27.22	55.56	73	1/10/2010	15:20:32	27.08 27.04 26.99	55.53 55.50 55.57	Mn4.2 Ml4.2 mb4.7	IGTU IIEES NEIC
Kahoorestan	4936/02	27.22	55.56	151	1/10/2010	17:17:47	27.12 27.05 27.06	55.46 55.48 55.61	Mn4.2 Ml4.2 mb4.7	IGTU IIEES NEIC
Firoozkooh1	4922/01	35.76	52.77	402	1/20/2010	5:20:05	35.82 35.87 35.88	52.86 52.86 52.91	Mn4.2 Ml4.2 mb4.5	IGTU IIEES NEIC
Firoozkooh1	4922/02	35.76	52.77	60	1/20/2010	5:26:21	35.78 35.92	52.84 52.82	Mn3.9 Ml3.8	IGTU IIEES
Firoozkooh1	4934	35.76	52.77	57	1/26/2010	1:52:25	35.79 35.74	52.85 52.66	Mn3.5 Ml3.7	IGTU IIEES
Tokmeh Danesh	4923/03	37.73	46.95	82	2/2/2010	10:16:28	37.86	46.84	Mn4.6	IGTU
Khajeh	4987	38.15	46.59	38			37.92 37.93	46.98 46.78	Ml4.3 mb4.6	IIEES NEIC
Hosseiniyeh Olya	4942/02	32.67	48.25	66	2/23/2010	10:39:03	32.55 32.58	47.95 48.38	Mn3.6 Ml3.3	IGTU IIEES
Hotkan	4967/03	30.85	56.79	70	3/23/2010	2:20:25	30.83 30.81	56.74 56.74	Mn3.6 Ml3.5	IGTU IIEES
Konar Takhteh	4958	29.53	51.4	139	5/14/2010	18:49:56	29.42	51.65	Mw5.1	BHRC
Dalaki	4957	29.43	51.29	86						
Kazeroon	4959/02	29.63	51.64	35			29.42	51.47	Mn5.1	IGTU
Saed Abad	4960	29.38	51.12	19						
Borazjan	4956/02	29.26	51.22	19			29.41	51.53	Ml5.2	IIEES
Tange Eram	4963/02	29.15	51.53	18						
Narges Zar	5098/01	29.45	51.89	18			29.32	51.56	mb5.1	NEIC
Shabankareh	4961	29.47	50.99	12						
Geno	5038	27.45	56.29	102	5/19/2010	19:41:46	27.33 27.37	56.27 56.20	Mn3.8 Ml3.9	IGTU IIEES

Station	Record No.	Coordinate		U.P.G.A (cm/s/s)	Origin Time		Epicenter		M	Ref.
		N	E		M/D/Y	h:m:s	N	E		
Armordeh	5033	35.93	45.8	100	6/5/2010	12:47:05	35.73	45.45	Mn3.8	IGTU
							35.88	45.56	Ml3.4	IIEES
Hotkan	5232/01	30.85	56.79	62	6/11/2010	10:38:37	30.92	56.72	Mn3.7	IGTU
							30.80	56.74	Ml3.6	IIEES
Dorahan	5043/02	31.62	51.19	99	6/26/2010	0:54:53	31.53	51.02	Mn3.0	IGTU
							31.50	51.11	Ml2.9	IIEES
Garmsar	5029	35.23	52.33	63	7/16/2010	3:41:47	35.19	52.28	Ml3.3	IIEES
							35.17	52.37	Mn3.3	IGTU
Eshkanan	4994/01	27.22	53.61	371	7/20/2010	19:38:10	27.16	53.92	Mw5.9	BHRC
Rostagh	4993	26.89	53.86	68						
Bandar-e-Moqam	4992	26.97	53.48	66			27.04	53.90	Mn5.8	IGTU
Beyram	4995/01	27.44	53.51	44						
Lamerd	5125/01	27.33	53.18	19			26.92	53.84	Ml5.7	IIEES
Bastak	4991/02	27.2	54.37	14						
Bahrestan	5123	27.7	52.73	10			26.98	53.86	Mw5.8	NEIC
Kish	4996	26.57	53.95	5						
Geno	5038	27.45	56.29	102	5/19/2010	19:41:46				
Eshkanan	4994/06	27.22	53.61	199	7/20/2010	20:01:28	27.10	53.78	Ml3.9	IIEES
							27.17	53.98	Mn4.1	IGTU
Eshkanan	5016/01	27.22	53.61	100	7/21/2010	7:51:11	27.28	53.59	Mn3.2	IGTU
Eshkanan	5016/02	27.22	53.61	394	7/24/2010	12:34:10	27.11	53.65	Mw5.1	BHRC
							26.65	53.57	Mn4.7	IGTU
Beyram	5024	27.44	53.51	18			26.94	53.73	Ml4.5	IIEES
Lamerd	5125/02	27.33	53.18	78			26.78	53.90	mb4.8	NEIC
Eshkanan	5016/04	27.22	53.61	64	7/24/2010	13:07:56	28.20	52.32	Mn2.9	IGTU
							26.85	53.48	Ml3.2	IIEES
Eshkanan	5016/10	27.22	53.61	65	7/24/2010	22:57:40	27.07	53.59	Mn3.6	IGTU
							26.95	53.54	Ml3.5	IIEES
Torbate Heiydaryeh	5006	35.27	59.22	434	7/30/2010	13:50:14	35.28	59.26	Mw5.9	BHRC
Yaqoobi Dam2	5093	35.16	59.41	381						
Jangal	5002	34.7	59.22	151						
Shadmehr	5005	35.17	59.04	89						
Yaqoobi Dam1	5092	35.16	59.41	68						
Kashmar	5003	35.24	58.47	44						
Chakhmagh	4999	35.28	59.83	34			35.22	59.25	Mn5.7	IGTU
Roshtkhar	5004	34.97	59.62	32						
Rivash	5018/02	35.48	58.47	31						

Station	Record No.	Coordinate		U.P.G.A (cm/s/s)	Origin Time		Epicenter		M	Ref.
		N	E		M/D/Y	h:m:s	N	E		
Feyz Abad	5000	35.01	58.78	27	7/30/2010	13:50:14	35.20	59.23	Ml5.8	IIEES
Azim Abad	4997	35.15	58.07	27						
Kowli	5087	34.01	59.37	22						
Chenar	5089	35.28	58.91	21						
Gonabad	5001	34.37	58.68	19						
Bardeskan	4998	35.27	57.97	18						
Bonyabad	5088	34.08	59.88	17						
Bajestan	5007	34.52	58.18	14						
Garmab	5086/02	33.88	59.7	13			35.25	59.29	Mw5.4	NEIC
Farrokhi	5085	33.83	59.53	12						
Darooneh	5090	35.18	57.42	10						
Torbate Jam	5091	35.23	60.63	10						
Laleh Zar	5014	29.52	56.81	115	7/31/2010	6:52:56	29.60	56.79	Mw5.7	BHRC
Cheshmeh sabz	5010	29.47	56.42	34						
Jiroft Dam1	5120	28.86	57.47	29						
Bardsir	5011	29.91	56.58	27			29.70	56.81	Mn5.8	IGTU
Baghin	5013	30.19	56.82	23						
Safa Dam	5238	29.26	56.97	17			29.63	56.75	Ml5.6	IIEES
Baft	5012	29.23	56.6	16						
Rayen	5009	29.61	57.43	14			29.70	56.81	mb5.5	NEIC
Davaran	5060	30.58	56.19	12						
Saed Abad	5055/01	29.38	51.12	131	8/5/2010	15:16:48	29.45	50.98	Mn4.0	IGTU
							29.43	51.18	Ml4.0	IIEES
Gifan	5008	37.89	57.49	17	8/8/2010	9:39:03	38.03	57.84	Mn3.8	IGTU
Robat	5017	37.9	57.7	70			37.96	57.72	Ml3.7	IIEES
Shirindareh Dam2	5288	37.71	57.11	107	8/11/2010	17:26:20	37.70	57.12	Mw4.4	BHRC
Shirindareh Dam1	5287/01	37.71	57.11	88						
Ashkhaneh	5023	37.56	56.92	31			37.85	57.15	Mn5.0	IGTU
Kohneh Jolgeh	5020	38.07	56.48	14			37.80	57.02	Ml5.0	IIEES
Raz	5019	37.94	57.1	14			37.90	57.12	mb5.0	NEIC

Station	Record No.	Coordinate		U.P.G.A (cm/s/s)	Origin Time		Epicenter		M	Ref.
		N	E		M/D/Y	h:m:s	N	E		
Kooh-e-Zar	5030/01	35.45	54.59	622						
Forat	5028	35.92	54.31	25			35.45	54.40	Ml5.9 Mw5.6	BHRC
Naeim Abad	5050	36.25	54.62	18						
Qoosheh	5051/02	35.96	54.03	18			35.49	54.47	Mn5.9	IGTU
Jam	5049	35.78	53.9	16	8/27/2010	19:23:48				
Semnan2	5310	35.59	53.44	13			35.43	54.46	Ml5.8	IIEES
Rajaei Dam 5	5333	36.25	53.23	12						
Qods	5048	36.36	55.44	11			35.46	54.55	Mw5.7	NEIC
Mojen	5031	36.48	54.65	10						
Kooh-e-Zar	5030/03	35.45	54.59	81			35.43	54.50	Ml5.2	IIEES
Moaleeman	5032	35.22	54.57	38	8/28/2010	0:29:03	35.49	54.44	Mn5.0	IGTU
							35.68	54.62	mb4.9	NEIC
Ghaemiyeh	5062	29.85	51.59	335						
Kazeroon	5065	29.63	51.64	117						
Konar Takhteh	5061	29.53	51.4	59						
Khan zeynioun	5063	29.67	52.15	44						
Gooyom	5096	29.82	52.39	40			29.78	51.76	Mw5.8 Ml6.1	BHRC
Baba Monir	5095	30.07	51.21	38						
Narges Zar	5098/02	29.45	51.89	35						
Bagcheh Jalil	5214/01	30.65	51.27	24						
Masiri	5079	30.25	51.52	23						
Zarghan	5066	29.78	52.7	20						
Vali Asr	5077	29.92	52.89	20	9/27/2010	11:22:46				
Shah Qasem Dam1	5311/01	30.58	51.57	19			29.72	51.55	Mn6.1	IGTU
Basht	5080	30.34	51.16	18						
Shiraz 3	5075	29.63	52.53	18						
Dodaj	5072	29.54	52.97	15						
Shabankareh	5074	29.47	50.99	14						
Sepidan	5064	30.27	51.98	14						
Arsanjan	5069	29.91	53.31	13			29.66	51.74	mb5.9	IIEES
Saadat-shahr	5076	30.08	53.13	13						
Zarrat	5073	29.09	52.85	13						
Margoun	5107	30.99	51.09	12						

Station	Record No.	Coordinate		U.P.G.A (cm/s/s)	Origin Time		Epicenter		M	Ref.
		N	E		M/D/Y	h:m:s	N	E		
Apadana	5094	29.93	52.89	12						
Mansorkhani	5078	30.64	51.81	12						
Tange Eram	5084	29.15	51.53	11						
Chehel Zaree	5070	29.49	50.86	11						
Maharloo	5067	29.52	52.82	11	9/27/2010	11:22:46	29.65	51.69	Mw5.5	NEIC
Dogonbadan	5071	30.35	50.79	11						
Pataveh	5081	30.96	51.26	11						
Booshehr 5	5104	28.9	50.82	10						
Reygan	5130	28.65	59.01	126						
Zeh Kelot	5143	27.79	58.59	77						
Ghale Ganj	5139/02	27.52	57.88	70						
Roodbar	5136/02	28.03	58	67			28.32	59.19	Mw6.5 Ml6.4	BHRC
Posht Rood	5144/02	29.12	58.38	62						
Barvat	5131	29.07	58.4	49						
Jiroft	5132	28.67	57.74	44						
Fahraj	5135	28.95	58.89	30						
Qotb Abad	5133	28.88	58.48	25						
Hossein Abad	5128	28.46	57.74	21			28.53	59.13	Mn6.5	IGTU
Bampoor	5147	27.2	60.45	20						
Darbehesht	5138	29.24	57.33	18						
Abaragh	5146	29.35	57.94	18	12/20/2010	18:41:59				
Dalgan	5134	27.48	59.45	17						
Iran Shahr	5148	27.2	60.69	17						
Jiroft Dam3	5145	28.86	57.47	16			28.36	59.22	Ml6.2	IIEES
Kahnooj	5140	27.95	57.71	16						
Mohammad Abad	5129	28.91	57.89	14						
Sirch	5149	30.2	57.56	13						
Bazman	5137	27.86	60.18	12						
Kishit	5142	29.85	58.15	12						
Golbaf1	5141	29.89	57.73	12			28.49	59.12	Mw6.7	NEIC
Soghan	5212/01	28.35	56.88	11						
Chah Ali	5181	27.1	59.72	11						