International Journal of Architectural, Civil and Construction Sciences
ISSN: 2415-1734
Vol:10, No:6, 2016

Microseismicity of the Tehran Region Based on Three Seismic Networks

Jamileh Vasheghani Farahani

***Abstract*—**The main purpose of this research is to show the current active faults and active tectonic of the area by three seismic networks in Tehran region: 1-Tehran Disaster Mitigation and Management Organization (TDMMO), 2-Broadband Iranian National Seismic Network Center (BIN), 3-Iranian Seismological Center (IRSC). In this study, we analyzed microearthquakes happened in Tehran city and its surroundings using the Tehran networks from 1996 to 2015. We found some active faults and trends in the region. There is a 200-year history of historical earthquakes in Tehran. Historical and instrumental seismicity show that the east of Tehran is more active than the west. The Mosha fault in the North of Tehran is one of the active faults of the central Alborz. Moreover, other major faults in the region are Kahrizak, Eyvanakey, Parchin and North Tehran faults. An important seismicity region is an intersection of the Mosha and North Tehran fault systems (Kalan village in Lavasan). This region shows a cluster of microearthquakes. According to the historical and microseismic events analyzed in this research, there is a seismic gap in SE of Tehran. The empirical relationship is used to assess the Mmax based on the rupture length. There is a probability of occurrence of a strong motion of 7.0 to 7.5 magnitudes in the region (based on the assessed capability of the major faults such as Parchin and Eyvanekey faults and historical earthquakes).

***Keywords*—**Iran, major faults, microseismicity, Tehran.

I. Introduction

TEHRAN area is located on the foothills of the Alborz Mountain range surrounded by several important faults. Seismicity studies in Tehran region due to the north and south faults of Tehran as well as the development of urban space are vital. Two of the most important events recorded recently in Tehran have been occurred in the south-east of Tehran on October 17, 2009, Mw = 4.0 [1] and February 20, 2011, Mw = 4.1, near Eyvanekey Fault. Historical earthquakes have occurred in Tehran zone due to Mosha, Taleghan, Garmsar, Parchin and Eyvanekey faults. Eyvanekey and Taleghan faults produced the largest events with a magnitude of Ms ~7.6 during the 4th century BC and Ms~7.7 in the 10th century, respectively. Therefore, Ambraseys and Melville 1982 [2] showed that several historical earthquakes occurred around the Mosha, North Tehran, Eyvanekey and Garmsar faults in Tehran zone.

II. Data Collection

We used three seismic networks in Tehran area. Microearthquakes analyzed around Tehran region by permanent seismological networks. All available events from 2004 to 2010 were obtained from TDMMO that is a short period network in Tehran area. TDMMO contains 13 seismic stations equipped with CK-1Ï seismometers with a natural frequency of 1 Hz. The information about the stations is listed in Table I.

Iranian Seismological Center (IRSC) has 12 short period seismic stations equipped with SS1 seismometers. The coordinates of the stations are listed in Table II. IL3 and TBB are not short period stations and are not active now, as well as Ajjeh station. We used data from 1996 to 2015. Table II shows the location of seismic stations.

Other seismic activities in Tehran were recorded by the permanent Broadband Iranian National Seismic Network Center (BIN) using Guralp CMG-3TD instruments from 2004 to 2010. Table III lists the station names and coordinates for BIN Network.

III. Tectonic Setting

Iran is located in Alpine-Himalayan seismic belt, and Tehran region is situated in the Alborz and central Iranian tectonic zones [3]. The Alborz mountain belt is an active zone with a width of 100km and a length of 600km and a NW-SE to EW trending mountain belt. It is constructed during Precambrian, Mesozoic and Tertiary phases [4]. This important zone is bounded by Talesh Mountain in the west and Kopeh Dagh Mountain in the east. Based on [5] the total crustal shortening is estimated about 30 km at the longitude of Tehran from the early Pliocene. The most important faults in the region are located in south of Tehran including Kahrizak and Eyvalekey faults and in North of Tehran including North Tehran and Mosha faults. The microseismicity studies were conducted in the region by minor faults [6] shown in Fig. 1.

IV. Historical and Instrumental Seismicity

Microseismicity in Tehran region recorded at IRSC network from 2006-2015 (Fig. 2) for all data (tectonic and small explosion events). We had some limitations in recent data for discrimination of events in recent years. We needed waveforms to categorize them, but they were not accessible for all magnitudes.

Jamileh Vasheghani Farahani is with the Department of Seismology, University of Tehran, Tehran, Iran (e-mail: j_farahani@ut.ac.ir).

TABLE I
LOCATION OF SEISMIC STATIONS FOR TEHRAN NETWORK

Station Name	Latitude(deg)	Longitude(deg)	Altitude(m)	Geographic Location
1	35°N 38.24′	51°E 22.18′	1100	*Shariati Park*
102	35°N 29.00′	51°E 23.26′	983	*Ghasem Abaad*
3	35°N 36.20′	51°E 7.84′	1090	*Saba Shahr*
105	35°N48.69′	51°E 10.51′	1864	*Vardyj*
6	35°N 49.34′	51°E 15.82′	1680	*Sulaqan*
7	35°N 48.53′	51°E 23.55′	1820	*Velenjak*
8	35°N 49.52′	51°E 27.84′	1851	*Jamshidieh Park*
109	35°N 49.15′	51°E 31.62′	2110	*Shahid Mahalati Area*
10	35°N 45.93′	51°E 35.80′	1676	*North of Tehran Pars*
12	35°N 27.59′	51°E 31.17′	967	*Eshghabad*
13	35°N 43.50′	51°E 20.37′	1274	*TDMMO*
14	35°N 41.69′	51°E 35.78′	1666	*Hameh Sin*
16	35°N 34.30′	51°E 35.79′	1231	*Lapeh Zanak*

TABLE II
STATION COORDINATES

Station Name	Station Code	Latitude (deg)	Longitude (deg)	Altitude (m)
Afjeh	AFJ	35.8560	51.7125	2750
Damavand	DMV	35.5772	52.0322	2546
Firozkooh	FIR	35.6415	52.7536	2380
Ghazvin	GZV	36.3859	50.2184	2100
Mahdasht	MHD	35.6853	50.6675	1150
Qom	QOM	34.8424	51.0703	2270
Razeghan	RAZ	35.4046	49.9290	1950
Sefidab	SFB	34.3518	52.2406	948
Tehran	THE	35.7367	51.3817	1462
Hasanabad	HSB	35.4275	51.3567	1098
Varamin	VRN	34.9954	51.7273	855
Varamin	TBB	34.9954	51.7273	855
ILPA	IL3	35.4761	51.0238	989
ILPA	IL5	35.2128	50.5811	1385
Amirabad	TEHA	35.756	51.387	1418

TABLE III
STATION COORDINATES

Station Name	Station Code	Latitude(deg)	Longitude(deg)	Elevation(m)
Tehran	THKV	35.916	50.879	1795
Ashtian	ASAO	34.548	50.025	2217
Tehran	CHTH	35.908	51.126	2350
Damavand	DAMV	35.630	51.971	2520
Ghom	GHVR	34.480	51.295	927
Persian Gulf	BNDS	27.399	56.171	1500
Bojnurd	BJRD	37.700	57.408	1337
Germi-Ardebil	GRMI	38.810	47.894	1300
Ghir-Karzin	GHIR	28.286	52.987	1200
Ghom	GHVR	34.480	51.295	927
Kerman	KRBR	29.982	56.761	2576
Khomeyn	KHMZ	33.739	49.959	1985
Maku	MAKU	39.355	44.683	1730
Maravetape	MRVT	37.659	56.089	870
Naein	NASN	32.799	52.808	2379
Ramhormoz	RMKL	30.982	49.809	176
Sanandaj	SNGE	35.093	47.347	1940
Shahrakht	SHRT	33.646	60.295	837
Shahrood	SHRD	36.000	56.01	1264
Shooshtar	SHGR	32.108	48.801	150
Tabas	TABS	33.469	57.119	-- ---
Zahedan	ZHSF	29.611	60.775	1575
Zanjan	ZNJK	36.670	48.685	2200

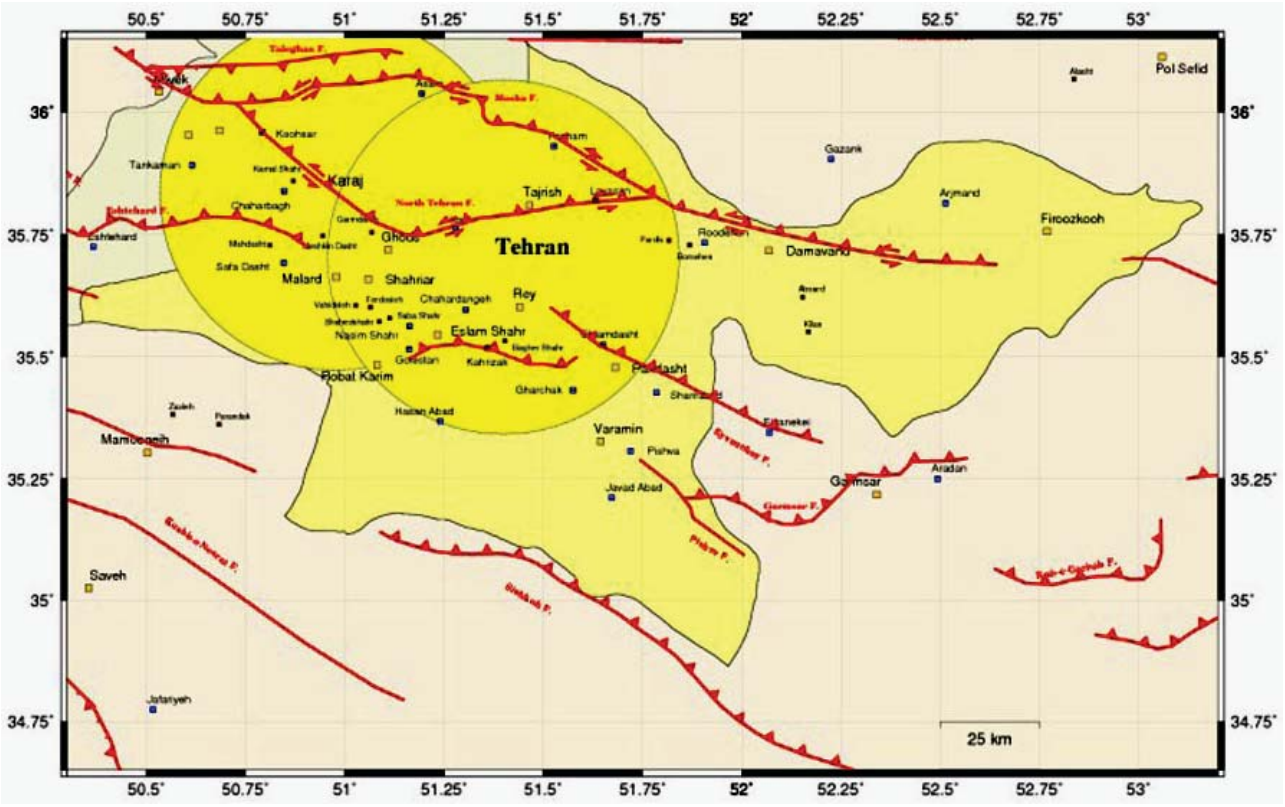

Fig. 1 Map of active faults in the Tehran region

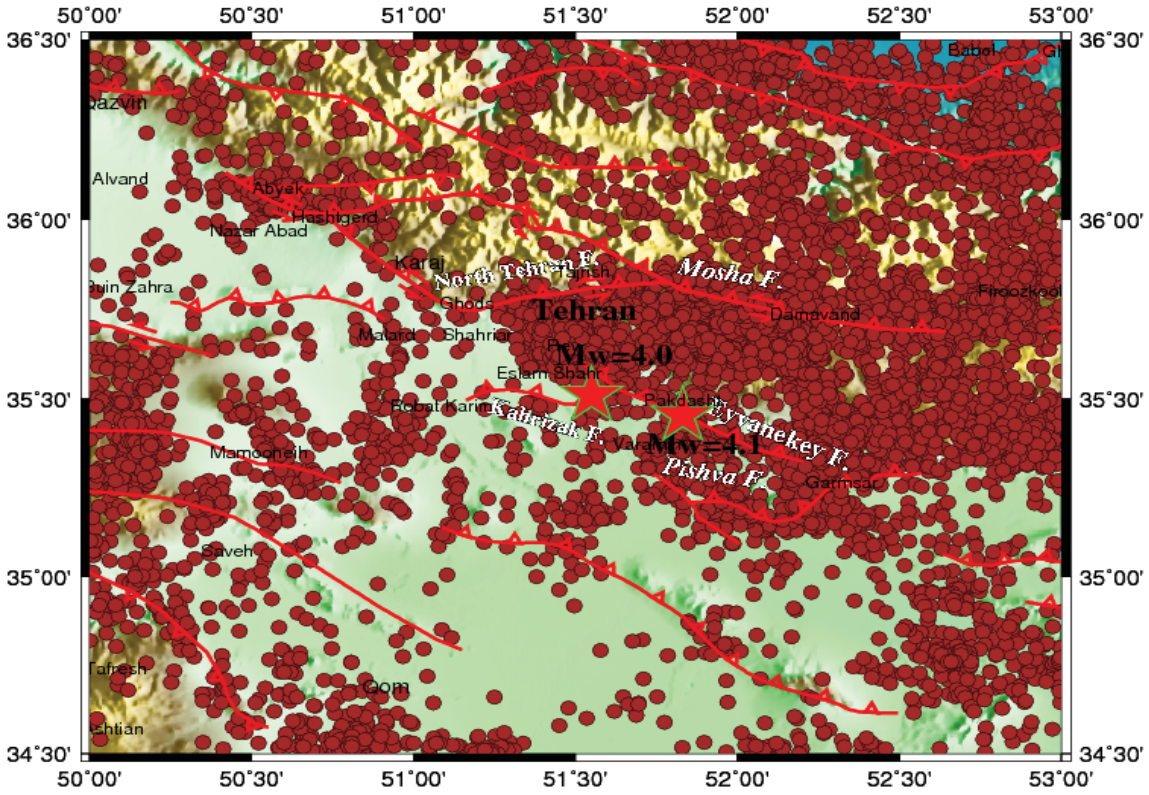

Fig. 2 Microseismicity map of Tehran region, IRSC network

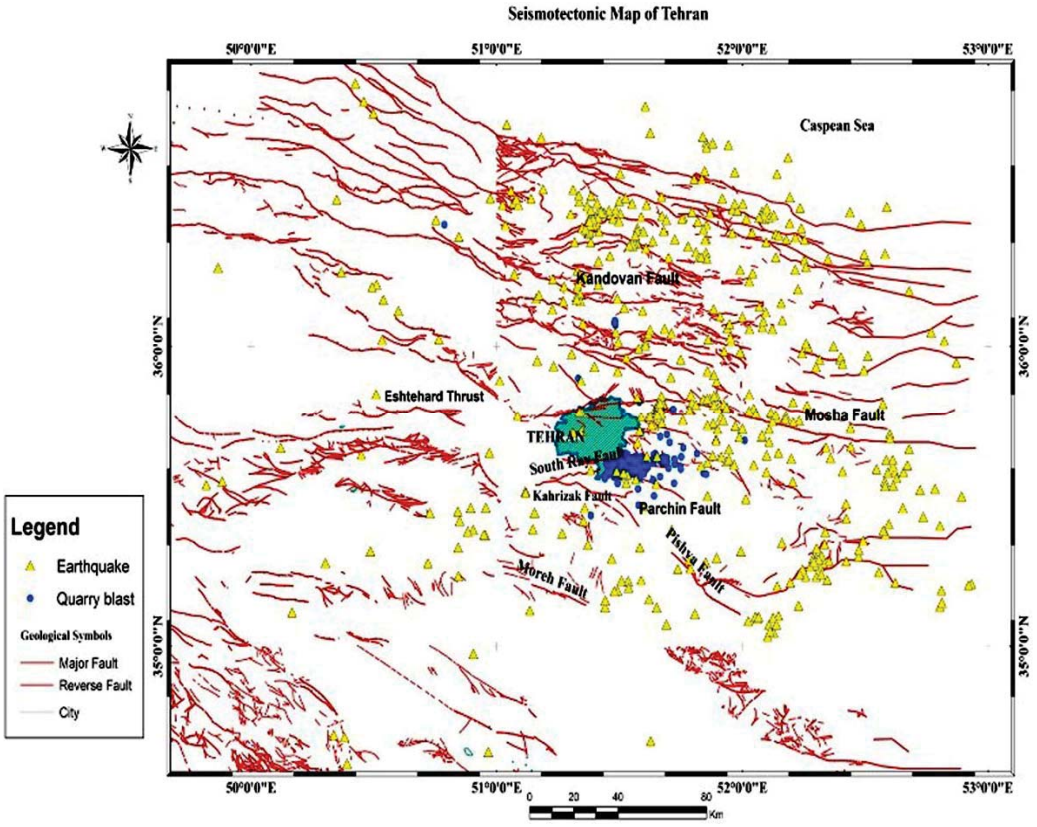

Fig. 3 Microseismicity map of TDMMO network in Tehran region from 2004 to 2010 (circles (●) for quarry blasts and triangles (▲) for microearthquakes

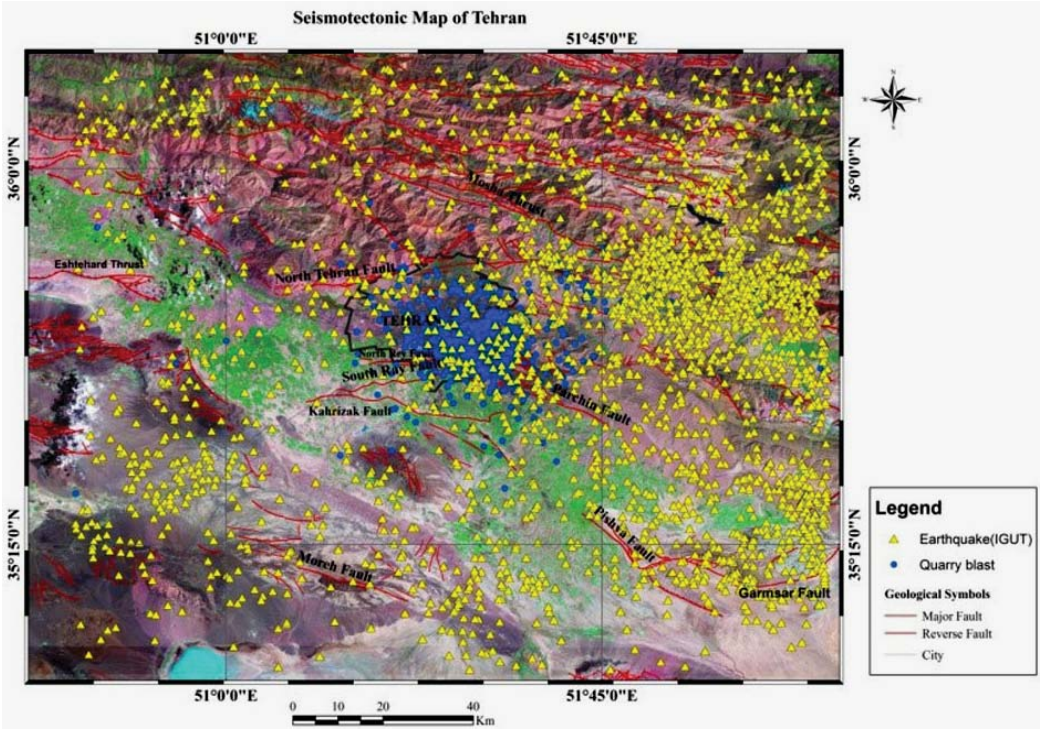

Fig. 4 Microseismicity map of IRSC network in Tehran region from 1996 to 2010 (blue circles for quarry blasts and yellow triangles for microearthquakes

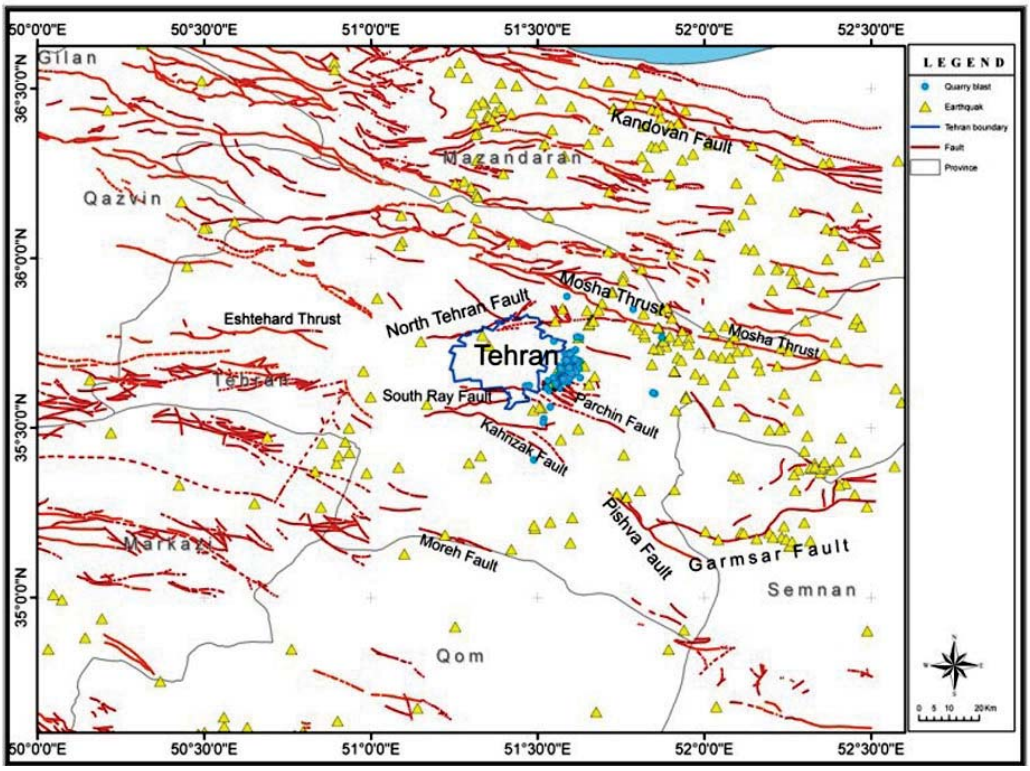

Fig. 5 Distribution of the seismic events for BIN network in Tehran region (2004-2010), blue circles for quarry blasts

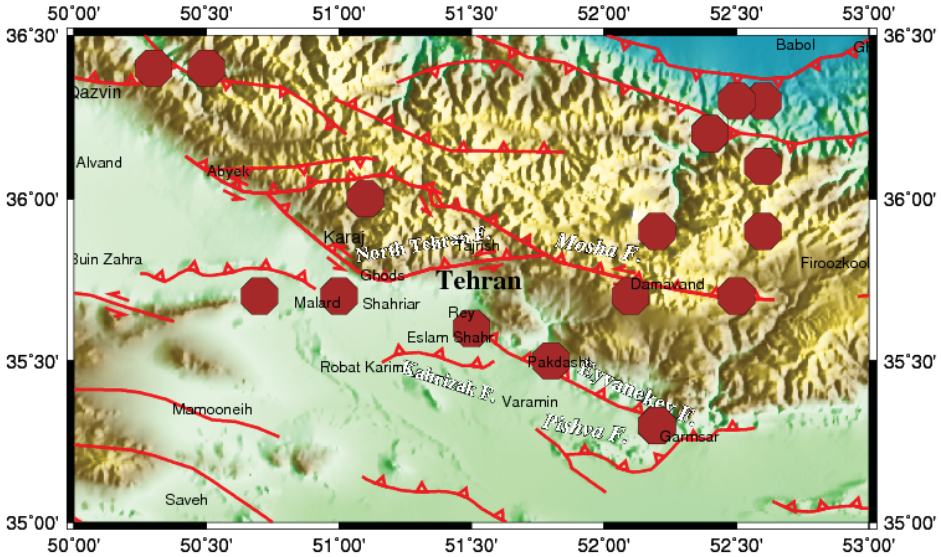

Fig. 6 Historical seismicity of Tehran region

We analyzed the data recorded by three seismic networks in Tehran area. There are several mines in the south and southeast of Tehran that are active and are doing small explosions. We tried to remove the explosions from our catalogs. Discrimination between microearthquakes and small explosions done by neuro-fuzzy inference system (ANFIS) helped us to make an independent catalog of small explosions in the region. We formed a separate catalog of tectonic earthquakes for Tehran region. For TDMMO network, we showed our catalog in Fig. 3 [7].

In Fig. 3, blue circles show small explosions in mines in the Tehran region. Fig. 4 shows the distribution of the microseismicity of Tehran network (IRSC) recorded at 12 stations from 1996 to 2010 [8].

Our other catalog recoded data from BIN network in Tehran. Fig. 5 represents the microearthquakes and the quarry

blasts recorded at this network from 2004 to 2010 in Tehran region [9]. Microseismicity data for three catalogs showed that most of the seismicity has accumulated in east and south-east of Tehran region. The most important fault in Tehran region that has experienced earthquakes with magnitudes bigger than 6.5 is Mosha fault. Historical earthquakes of Tehran region are displayed in Fig. 6. The distribution of historical events around Tehran like Rey, Eyvanekey, Garmsar, Taleghan, Damavand and North Alborz shows that the area has experienced about 16 earthquakes.

V. Discussion

Based on the historical and instrumental data provided by three seismic networks in Tehran region, it can be observed that the microearthquakes in the east of Tehran are more active than those in the west. Moreover, two of the important events in recent years (October 17, 2009, Mw = 4.0 and February 20, 2011, Mw = 4.1) were occurred in south of Tehran, is a warning to pay more attention to this region (Fig. 2). There are some active trends in the region with cluster of microearthquakes. One of the most important trends is located near the Mosha and North Tehran faults. Indeed, there is a major cluster of recent microearthquakes around the intersection of the Mosha and North Tehran fault systems (Kalan village). Kalan village in Lavasan is located approximately at a distance of 35 km from Tehran. Seismic gap on segment of faults in south and south-east of Tehran is a very important issue, especially in areas where a large population lives in the fault zones. Generally, the region under this research in terms of seismicity is very important.

VI. Conclusion

In this research, with regard to the fact that Tehran region is surrounded by several active faults, the microseismicity was studied by the data provided by three seismic networks (TDMMO, IRSC, and BIN) in Tehran region. The distribution of events showed some important active trends in North, NE, South and SE of Tehran. North Tehran fault passes through the urban area in Tehran. A large number of residential houses are made on the hanging wall of the fault. On the other hand, Mosha fault is close to the north and north-east of Tehran, and Kalan village in Lavasan area is located at the intersection of two important faults (Mosha and North Tehran fault) that have experienced significant historical earthquakes. Moreover, the instrumental activities (accumulation of microearthquakes) have recently been observed in this region. Therefore, non-standard construction should be prevented in this region. There are several active faults like Eyvanekey, Kahrizak, Ray, Pishva and Garmsar in south and south east of Tehran with the important historical earthquakes (300, 743, 855 and 856 with magnitudes bigger than 7.0). Moreover, these regions are very active in the occurrence of microearthquakes with magnitudes less than 4.0. In recent years, there were two important events (October 17, 2009, Mw = 4 and February 20, 2011, Mw = 4.1) in this area. Therefore, based on the historical and instrumental activities and fault lengths like Eyvanekey, Kahrizak and Pishva), there might be a possibility of events with magnitudes 7-7.5 in the future. The empirical relationship [10] Mw = LnLF+3.66 has been used to assess the M_{max} based on the rupture length. According to the important seismic gap in SE of Tehran, particular attention should be paid to crowd control and effete texture (old urban districts) in south and south-east of Tehran.

References

[1] J. Vasheghani-Farahani, M. Zaré, "The southeastern Tehran earthquake of 17 October 2009 (Mw = 4.0)". 2011, Seismological Research Letters, 82 (3), pp. 404-412.
[2] N. N. Ambraseys, C. P. Melville, "A History of Persian Earthquakes". Cambridge Earth Science Series. Cambridge and New York: Cambridge University Press, 1982.
[3] J. S. Tchalenko, B. J. Braud, M. Berberian, "Discovery of three earthquake faults in Iran". 1974a, Nature, 248, pp. 661-663.
[4] J. Stocklin, "Possible ancient continental margin in Iran. In: Burke, C., Drake, C. (Eds.), Geology of Continental Margins", 1974, Springer-Verlag, New York, pp. 873-877.
[5] M. B. Allen, M. R. Ghassemi, M. Sharabi, M. Qoraishi, "Accomodation of late Cenozoic oblique shortening in the Alborz range, northern Iran", 2003, Journal of Structural Geology, 25, pp. 695-672.
[6] J. Vasheghani-Farahani, M. Zaré, A. Cichowicz, "Microseismicity of the Tehran region based on the data recorded in a local monitoring network: 2004-2010", 2014, Episodes, 37 (3), pp. 206-217.
[7] J. Vasheghani-Farahani, M. Zaré, C. Lucas, "Adaptive neuro-fuzzy inference systems for semi-automatic discrimination between seismic events: A study in Tehran region". 2012, Journal of Seismology, 6 (2), pp. 291-303.
[8] J. Vasheghani-Farahani, "Estimation of Ground-Motion Prediction Equation for Quarry Blast Motion", PhD Thesis, International Institute of Earthquake Engineering and Seismology, 2012.
[9] J. Vasheghani-Farahani, "Discrimination of quarry blasts and microearthquakes using adaptive neuro-fuzzy inference systems in the Tehran region". 2015, Episodes, 38 (3), pp. 162-168.
[10] M. Zaré, "An Introduction to Applied Seismology. Tehran: Institute of Earthquake Engineering and Seismology (in Persian), 2005.