

Seismic activity in north central Alborz around Karaj region, revealed by local seismic network

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ABSTRACT :

Historical background and instrumentally located earthquakes as well as the geological evidences all suggest that north central Alborz around Karaj region in Iran is one of the seismically active regions in the Middle East. In 1996, as a part of national seismic network, the Geophysics Institute of Tehran University deployed a telemetric seismic network in Alborz around Karaj region mainly to monitor local earthquakes. Relying on the records obtained during 1996-2007, several seismically active areas with the following aspects could be recognized. The epicenters of local earthquakes are in good agreement with the location of major faults as well as the regional tectonic settings. The distribution of earthquakes in eastern and western parts of the region are consistent with the related major faults. A kind of seismic quiescence exists in the central part of the Alborz around the Karaj city. A similar situation could be observed along the south eastern extension of Rudbar fault system. Most of the recorded earthquakes have shallow depths indicating that the seismic activity is mainly taking place in upper crust and the seismogenic layer has a thickness of about 20 km. Taking into account the historical background and the present situation, the occurrence of a major earthquake in Alborz in the vicinity of Karaj is not far from expectation.

KEYWORDS: historical earthquakes, seismic activity, seismogenic zones, activ faults, local seismic network.

1. Introduction

Since 1996, a telemetric seismic network has deployed in Alborz. In this paper, the geological background of Alborz around Karaj region is overviewd and the detailed map of active faults in the region are presented. Then, the historical earthquakes in Alborz around Karaj city are summarized. Next, the instrumentally recorded earthquakes during 1900-2007 are presented. Finally, the locally recorded earthquakes during 1996-2007 are analyzed and discussed with the other results. The region referred in this study is situated between 49° and 53° east longitudes and 35° and 37° north latitudes. The region consist of a broad arch of parallel anticlines and synclines which forms the southern border of the vast depression of the Caspian Sea. Geological evidences and fault plane solutions of earthquakes in Alborz around Karaj region indicate the existence of both thrust and conjugate strike-slip faulting (Jackson, 1992). Using the geological information and air-photos, an attempt has been made to provide a detailed fault map, including the observed local faults in this region. Figure 1 shows the detailed major fault map of north central Alborz around Karaj region. As indicated in this figure, several major faults with almost eastwest trends in north and northeast Tehran, the Rudbar fault system in northwest the Ipack in west are examples of well known major faults in Alborz around Karaj city that have experienced destructive earthquakes in the past. In addition to these major faults, central Alborz includes a remarkable number of minor faults. All the observed minor faults are mapped and drawn with other active faults in figure 1. The distribution of minor faults in central and east central parts is significant. Several groups of faults with different trends could be observed in figure 1 indicating a complicated pattern of deformation in Alborz around Karaj region. Geological evidence and fault plane solutions of earthquakes in Study region indicate the existence of both thrust and conjugate strike-slip faulting(Jackson, 1992). Historical earthquakes of the Iranian plateau, including Alborz around Karaj region, has been studied by several investigators (Ambraseys, 1974; Ambraseys & Melville, 1982; Berberian, 1976). Though the historical earthquakes are imperfectly known, these studies suggest that Alborz around Karaj region has experienced many destructive earthquakes in historical time. The major faults with Historical earthquakes map in Study region is given in figure 2.

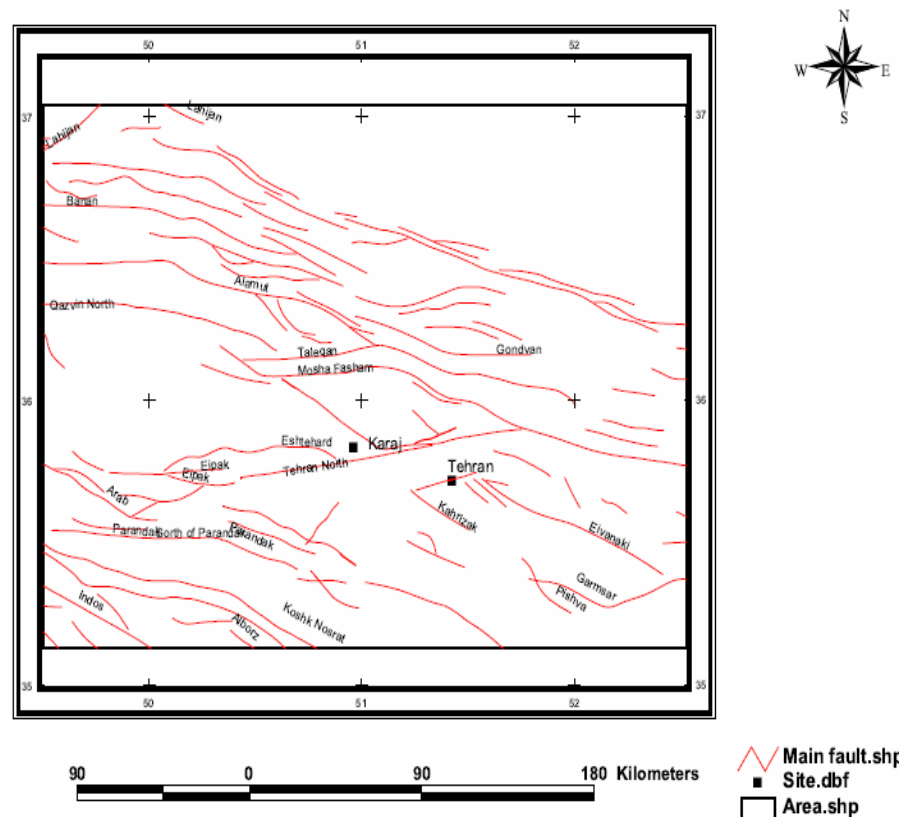


Figure 1 Major faults map of Study region

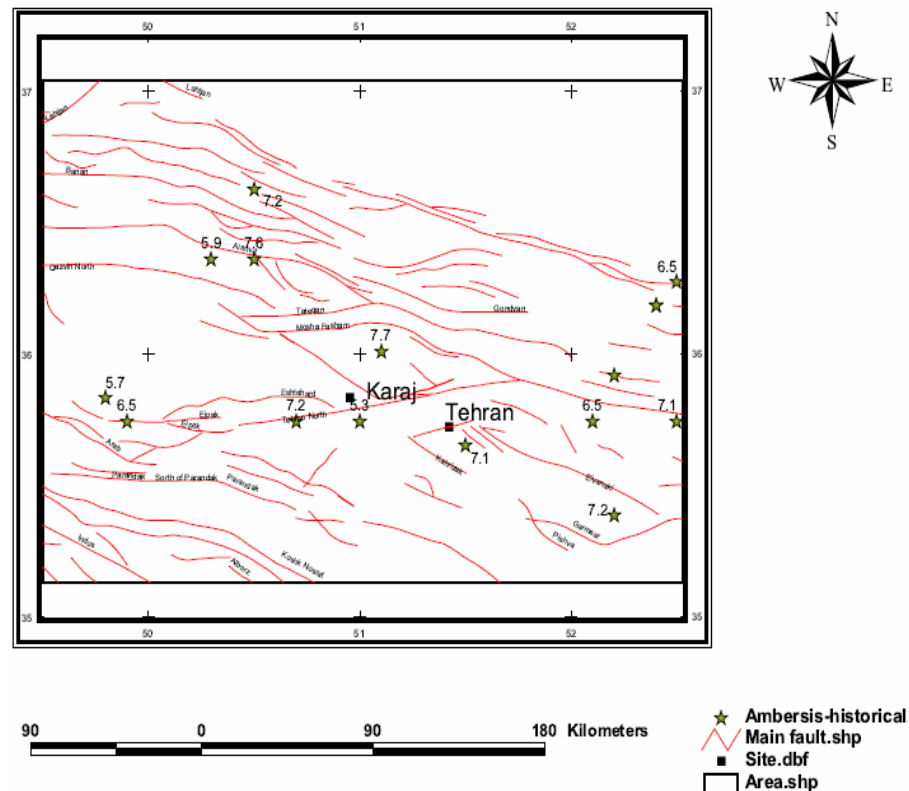


Figure 2 The major faults with Historical earthquakes map of Study region

2. Data analysis

Compared with historical background, the seismicity of Alborz around Karaj city is better understood in the present century. From 1900 till 1924, no recorded earthquake was reported for the region. However, during 1925-2007, source parameters of about 597 instrumentally recorded teleseismic earthquakes in Alborz around Karaj city were reported by international seismological agencies. The reliability of source parameters depends on the quality and the quantity of seismic stations that have recorded these earthquakes. Recently, by remarkable developments in instrumentations and new techniques, the epicentral determination of earthquakes are much more reliable. The time-frequency diagram of the instrumentally recorded earthquakes, in Alborz around Karaj region, during 1925-2007 is given in figure 3. The magnitude-frequency diagram of these earthquakes during the same period is given in figure 4. These figures indicate that the earthquakes that have occurred in this region so far are mostly moderate and only the magnitude of 1962 Buyin-Zahra and 1990 Rudbar earthquakes exceeded 7. The seismicity map of Study region is given in figure 5. In this research, the studying region has been recognized according to geological and seismicity features of four seismogenic zones. figure 6 shows The four seismogenic zones map in Study region. The time-magnitude diagram for instrumentally recorded earthquakes white magnitude larger than 3.5 during 1996-2007 is shown in Figure 7. In 1996, as a part of national seismic network, a telemetric seismic network was deployed in Alborz around Karaj city to monitor the seismic activity. The network includes twelve remote stations and is designed to cover the major part of Alborz where the city of with dense population is located.



Figure 3 Time-frequency diagram for instrumentally recorded earthquakes in the Study region during 1964-2007

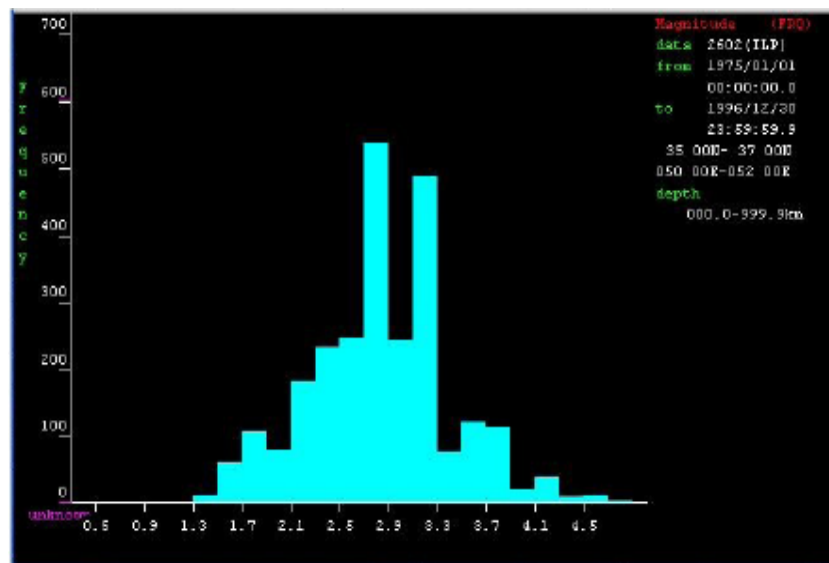


Figure 4 Magnitude-frequency diagram for instrumentally recorded earthquakes in Study region during 1964-2007. The horizontal axis indicates the magnitudes and the vertical axis indicates how frequently the earthquakes occurred

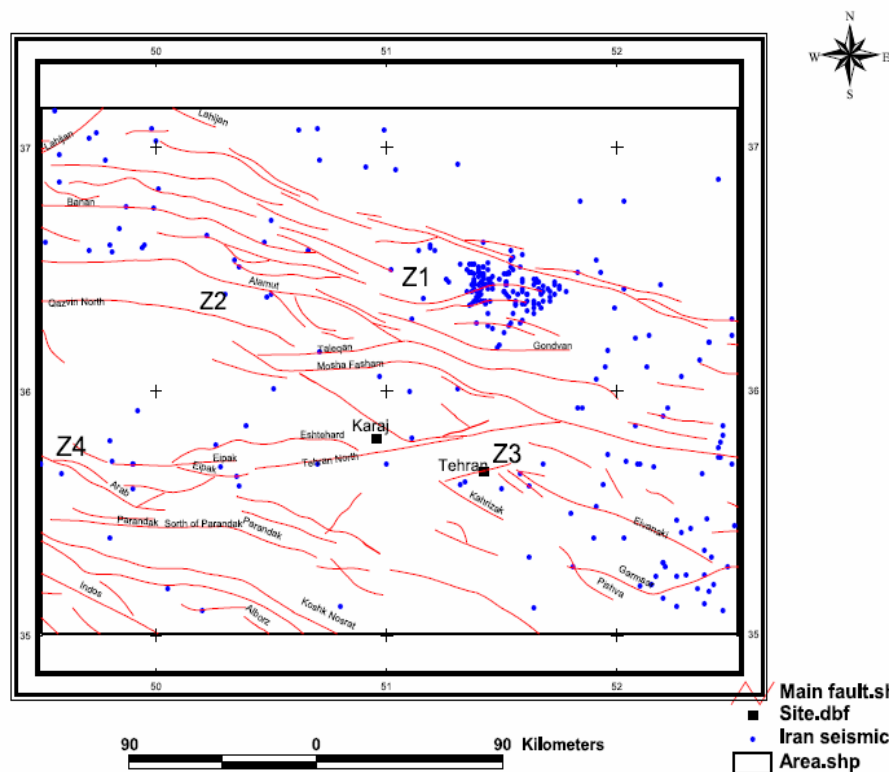


Figure 5 The seismicity map of Study region

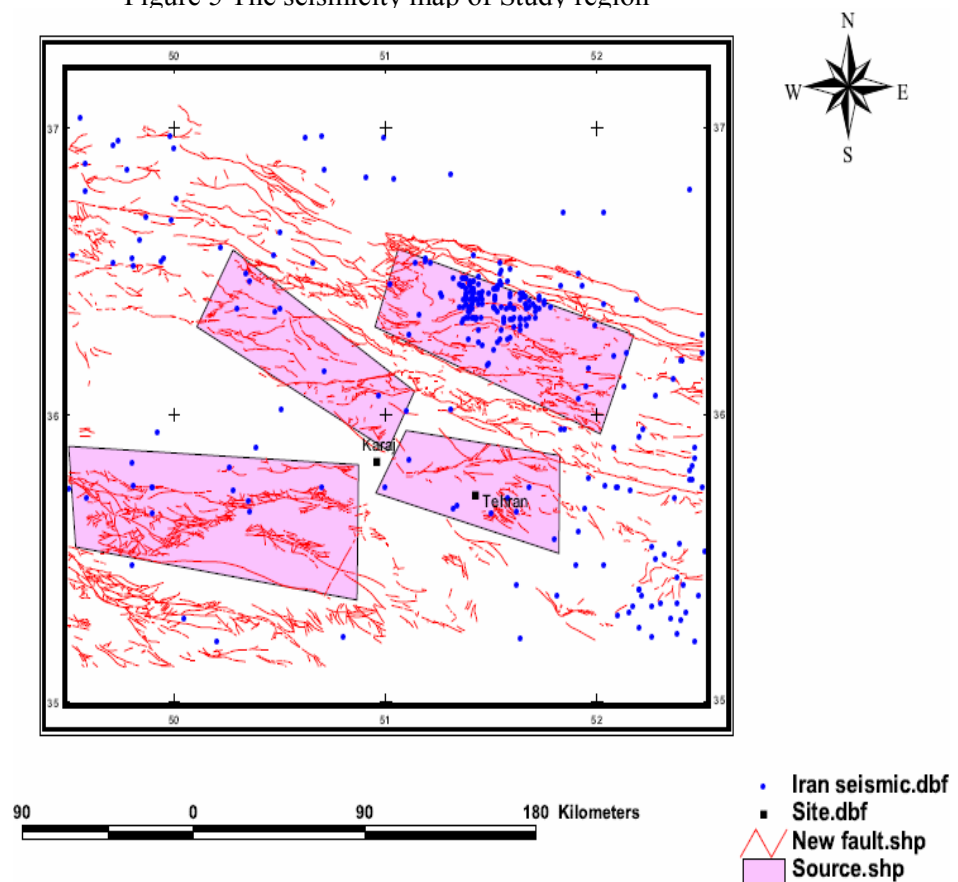


Figure 6 The four seismogenic zones map in Study region

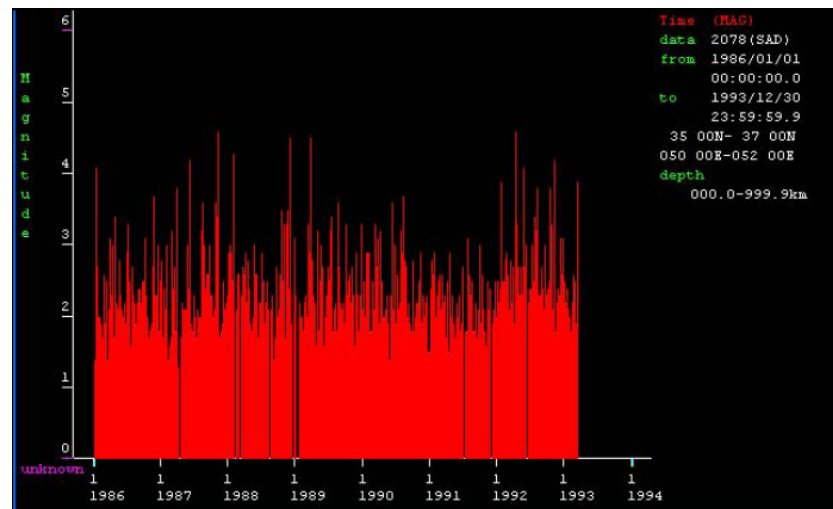


Figure 7 Time-magnitude diagram for instrumentally recorded earthquakes in the study region during 1964-2007

3. Conclusions

Historical documents indicate that Shahr Ray, the former capital of Iran has been devastated by earthquakes several times in the past. However, on the basis of those historical studies, it would appear that Karaj and surrounding areas have not experienced any major destructive earthquakes at least since the past centuries. The seismic quiescence has continued to the present day during the period in which instrumentally recorded data, including the records of local seismic network, has been reported. Comparison of the epicentral distributions given in figures 4 and 7 indicates that there is a good correlation between the seismic pattern of locally recorded earthquakes and the teleseismically recorded earthquakes. The seismically active areas could be distinguished in both figures. A kind of seismic quiescence exists in central part around Karaj.

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