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Research Note

Characteristics of the northwest seismological network in Iran

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Abstract

Northwest Iran is one of seismically active regions in Iranian plateau and has experienced many destructive earthquakes in the past centuries. Since 1996, the Institute of Geophysics, University of Tehran has deployed a telemetric seismic network in northwest Iran. The main purpose of the network is the acquisition of seismic data originated in a set of eight remote seismological stations, and investigation of the origin of processes that cause earthquakes in this region. The data is transmitted from each remote station through telemetric link to a central station located at Fatabad near Tabriz city where all the information is processed. In this paper, an overview of the northwest seismological network in Iran is presented and the instrument response is calculated by applying a synthetic signal (sine wave) which consists of different frequencies with uniform amplitude (unit volt) to the system as input. The new seismological network has been oriented towards forecasting and warning capabilities concerning earthquakes. It is to study the spatial and temporal seismic distribution to identify seismogenic sources, its mechanism and geometry; and to create public awareness about the causes, effects and mitigation of natural hazards.

Keywords: Seismic telemetric network, Seismicity of northwest Iran, Response curve, Data processing, Remote seismic station.

1. Introduction

Northwest Iran is located in a very complex tectonic environment, where two main seismic belts in Iran are converged and many destructive earthquakes have occurred in the past (Berberian, 1976). Historical documents indicate that many disastrous earthquakes have happened in the region (Ambraseys, 1974; Ambraseys and Melville, 1982). The historical documents and instrumentally recorded earthquakes by Global networks indicate that a kind of seismic quiescence exists in the central region (Sharabiani, 1997). Untill recently, very limited seismic station has been operating in northwest Iran. Therefore, the reliable determination of source parameters of local earthquakes was not possible and there were not enough reliable data to evaluate comprehensive seismic activity in this region (Asudeh, 1983; Ambraseys, 1978; Berberian, 1979).

The destructive earthquake of June 20th, 1990 with magnitude 7.3 and heavy human loss in northwest Iran highlighted the need to install a permanent seismological network in this region. Therefore, in 1996, the Institute of Geophysics, university of Tehran deployed a telemetric seismic network in northwest Iran to monitor the local earthquakes. Since then, many local earthquakes have been recorded by the northwest seismological network in Iran. As a reliable data the outcomes will be published in a report, separately. In this paper, the description of the northwest seismological network is given for the interest of those who may be contemplating about the installation of such a network. It is also to bring them the attention of the seismological community in general and to those who may find the data that will emerge from the network of interest in their particular studies.

2. An overview of the northwest seismological network in Iran

The northwest seismological network in Iran, at the first stage, consists of eight remote seismic stations and was designed to cover the central part of northwest Iran where Tabriz, the largest city in the region with more than four million inhabitants, is located. In the same region, during the past two centuries a kind of seismic gap was oberved. The locations of stations were selected in remote areas, away from various noises and in appropriate conditions from a geological point of view. The distribution of stations was designed so that to cover the activities of major faults in the area. Out of eight remote seismic stations, two have direct link and six were linked through repeaters. In future, the number of stations will be increased so that to create good station coverage for the whole region in northwest Iran. The locations of seismic stations are given in table 1 and the distribution of them is illustrated in figure 1. The main purpose of the network is the acquisition of seismic data originated in a set of remote seismological stations, and to investigate the

origin of processes that cause earthquakes. This information is transmitted from each remote station through telemetric link to a central station located in Tabriz where the information is processed. The accuracy of time in each seismic station is checked and if necessary adjusted by GPS, automatically. After receiving the time, the signal goes to the printers. This enables us to evaluate the seismic activity and the remote station data quality.

3. Remote seismic stations

The remote seismic stations are quiet sites which are good for receptions (figure 2). Each station has three short period seismometers, a three component digitizer and a telemetric equipment supported by solar batteries (figure 3). The seismometers are SS1 produced by Kinemetrics having a natural period of 1 Hz. Each remote seismic station also consists of a remote digitizer and a state of health analysis program that permits any problems at the outstation to be transmitted to the base. The data is digitized with a dynamic range of 136 db, 16 bit resolution, 50 sps, and state of health system information. The communication system works with VHF transmission. If there is a power failure, 2 batteries can work up to two weeks. Also there is lightning and power protection. The overview of remote seismic station in Amand is shown in figure 2.

4. Data processing center

The data processing center is located at the top hill in Fatabad village in the vicinity of Tabriz. The data is received in real time by radio wave transmission and the information is transferred to a computer system for analysis, storage and production of bulletins and maps. To process and locate the earthquakes, a software called DAN (Data Analysis System) provided by Nanometrics is used. It works under OS/2 in 32 bits or SUN workstations (DANUser's Guide, 1995). For locating the earthquakes, the modified version of HYPO71 program of Lee and Valdes (1985) is used. The software system is designed so that the data center can have access to the data centers of other seismic networks in the nation. It can send or receive waveform data by telephone line. The overview of main building for data processing center in Fatabad near Tabriz is shown in figure 4.

5. Response of the system

Any processing of the recorded earthquake data related to the dynamic behavior of the earthquakes requires precise frequency response of the recording instruments.

The instrument frequency response of northwest seismological network consists of SS1 seismometer and 16 bit digitizer model RD3. The method of calculation of frequency response is based on applying a synthetic signal (sine wave) containing different frequencies with uniform amplitude (unit volt). When the system input and output are known the instrument response can be calculated.

The recording instrument acts as a filter and affects the real seismic data. In order to get the real signals due to the actual movement of the earth, the effect of instrumental response should be removed from the recorded data. In this study instrument response curve of Tabriz is evaluated. By a signal generator, sine waves with constant amplitudes and different frequencies were produced and used as input to the seismometers. The analog output was digitized by 50 samples per second. For a time window of 45 seconds, the frequencies from 0.2 to 50 Hz were applied and a filter was designed in frequency domain so that to act equivalent to the response of the system. The amplitude response of the system is shown at the top of figure 5 and the phase response is indicated at the bottom of the same figure. The least significant bit is 1 nm/bit, and the dynamic range is 136 dB. The digitizer is a gain ranged 16-bit digitizer. A sample of recorded waveform of local earthquakes by a remote seismic station is given in figure 6. As it is indicated in the figure, the top trace is a sample of seismogram. The next trace is a selected part of the total trace. The bottom trace is the corrected one which does not include the instumental response.

6. Concluding remarks

The main purpose of the recent telemetric seismic network in northwest Iran is recording local earthquakes, the acquisition of seismic data originated in remote seismological stations, and investigation of the origin of processes that cause earthquakes. The new seismological network has been designed towards forecasting and warning capabilities concerning earthquakes, to study the spatial and temporal seismic distribution to identify seismogenic sources, its mechanism and geometry; and to create public awareness about the causes, effects and mitigation of natural hazards. With the operation of the new seismological network, northwest Iran faces a new stage in the knowledge and study of seismic activity. Furthermore, the new phases can be considered as

promises for much more safety and relaxed life for the native inhabitants.

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Table 1. Codes and location of remote seismological stations.

Number	St. code	Loc	Long	Lat	Alt
			E	N	(m)
1	TAB	Tabriz	46° 08′	38° 14′	1650
2	HRS	Heris	47° 03′	38° 20′	2100
3	SRB	Sarab	47° 40′	37° 50′	1950
4	HSH	Hashrud	47° 16′	37° 18′	2100
5	BST	Bostanabad	46° 53′	37° 41′	2100
6	AZR	Azarshahr	45° 59′	37° 41′	2300
7	SHB	Shabestar	45° 37′	38° 14′	2150
8	MRD	Marand	45° 43′	38° 43′	2150

Figure 1. The distribution of remote seismic stations in northwest Iran. Solid circles are the locations of remote stations and repeaters. The data processing center is shown by C. The directions of data transmissions are shown by arrows. Data of four remote stations in east and one station in south west are transmitted through two repeaters in east and west as shown in the figure.

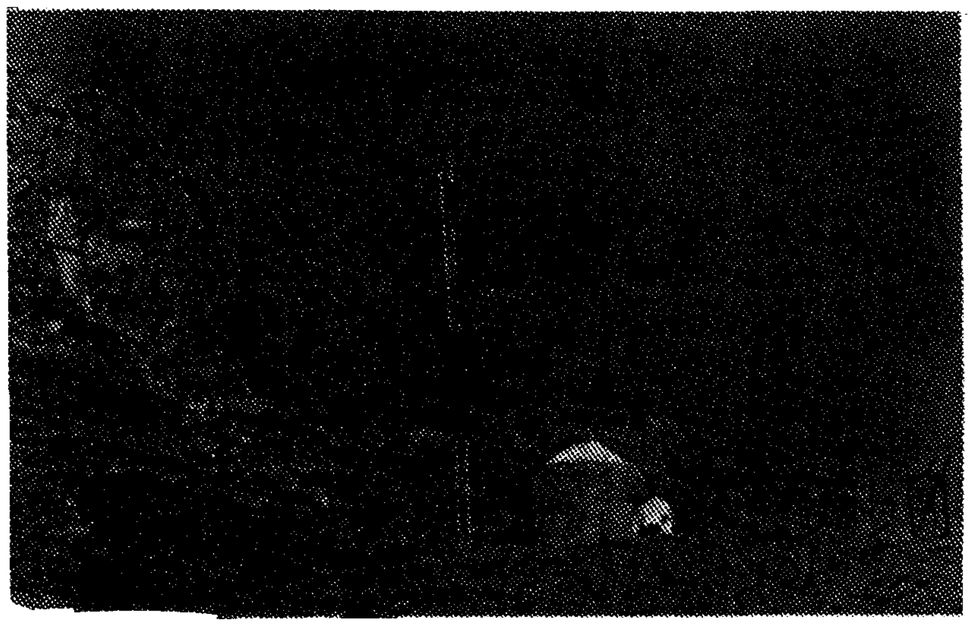

Figure 2. The overview of remote seismic station in Amand near Tabriz airport. This station is the repeater of Azarshahr remote station, as well.

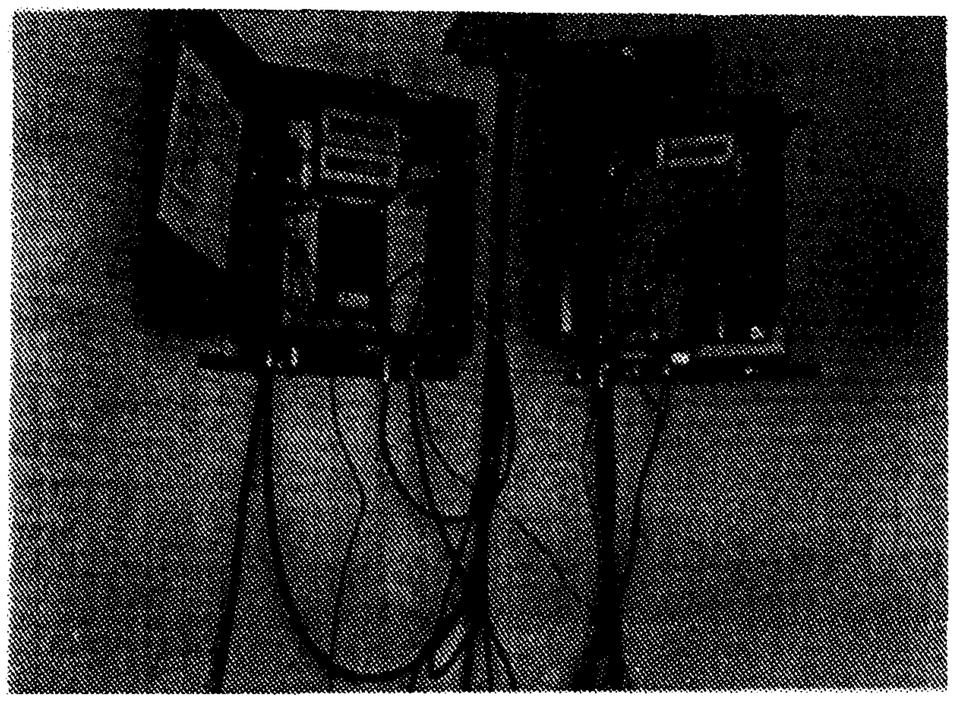

Figure 3. Each station has a seismometer, a digitizer and a telemetric equipment supported by solar batteries

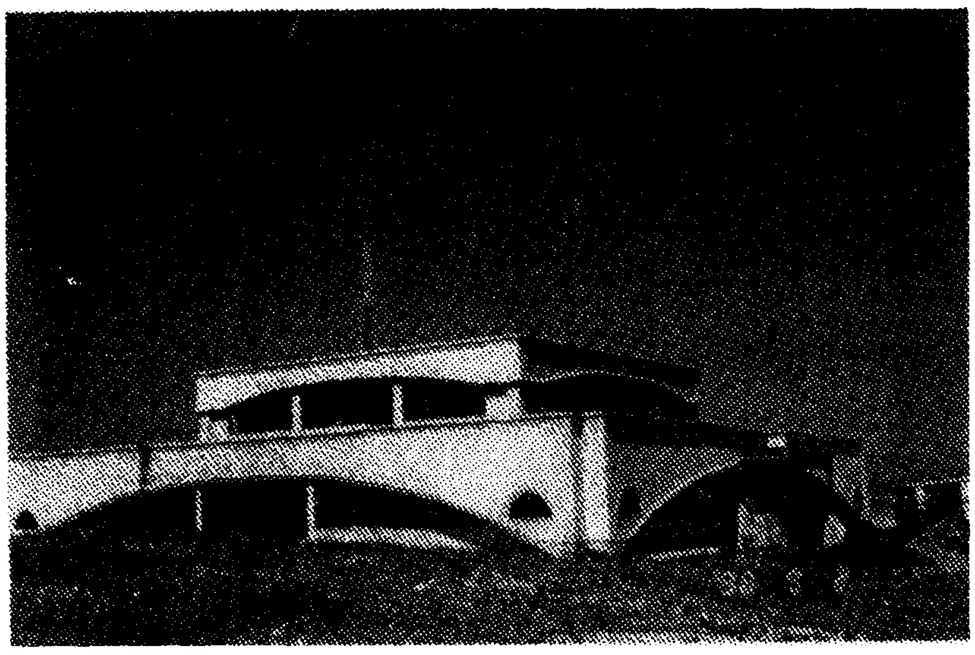

Figure 4. An overview of the main building of data processing center located at Fatabad in the eastern entrance of Tabriz city.

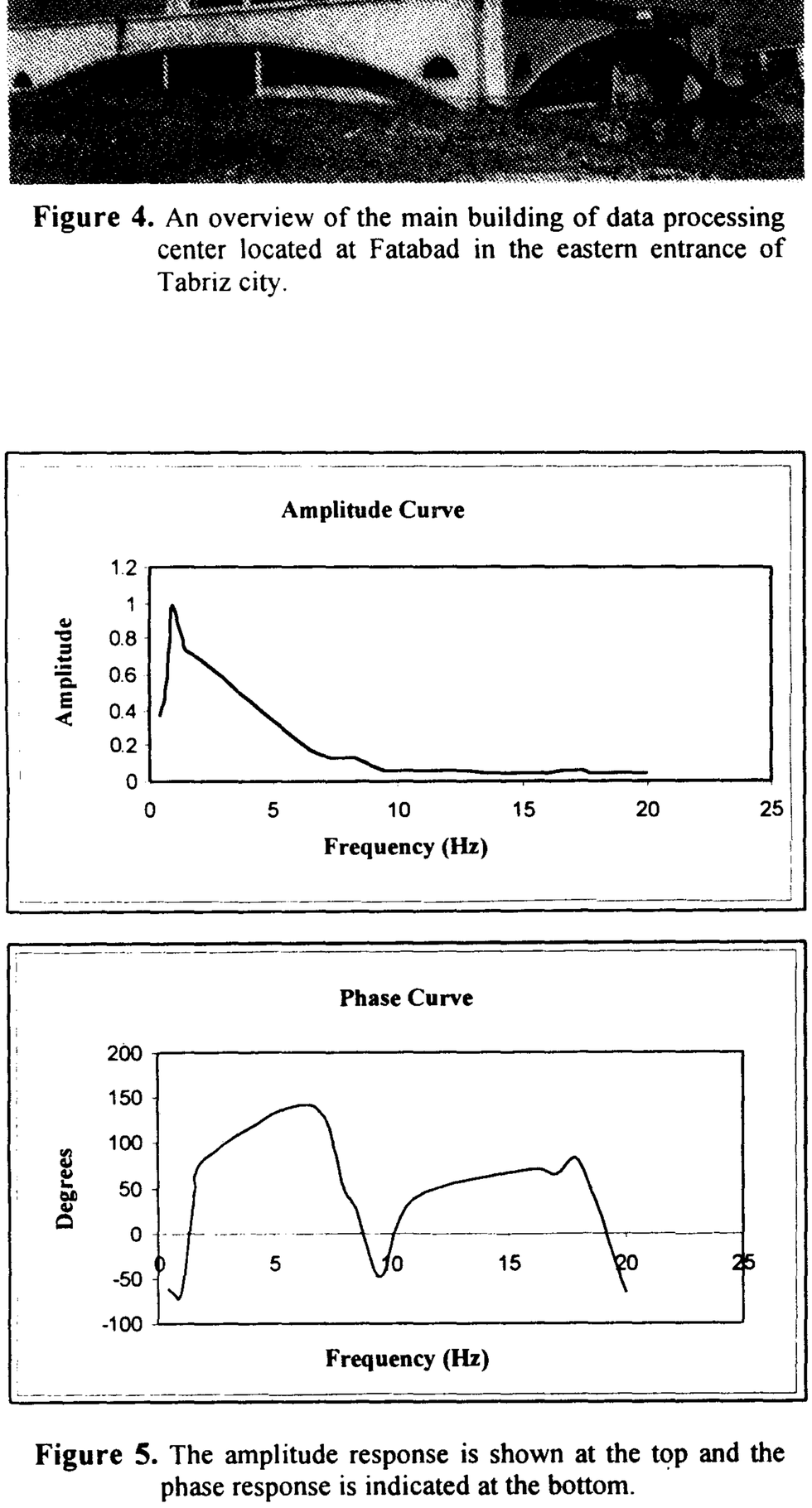

Figure 5. The amplitude response is shown at the top and the phase response is indicated at the bottom.

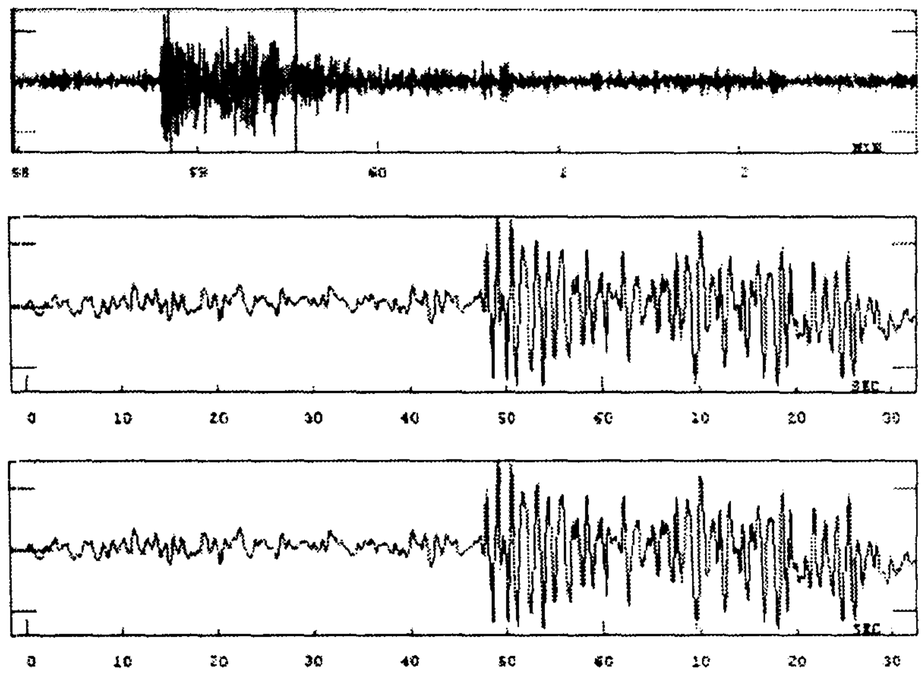

Figure 6. The top trace is a sample of recorded vertical component of original waveform in Shabestar seismic station from the earthquake that occurred on 9th of November 2000. The next trace is a selected part of the top trace. The bottom trace is corrected trace which does not include the instumental response.