May 1, 2003 Bingöl (Turkey) Earthquake

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Introduction

At least 176 people have died and 521 people were injured in an earthquake that shook the eastern Turkey's Bingöl province at 03:27 local time on 1 May 2003. According to the Kandilli Observatory, the epicenter of the earthquake that measured of magnitude Ms=6.4 was located at about 14 km N-NW of the Bingöl city (Figure 1). Several public buildings collapsed in the centre of Bingöl city and its vicinity. The last official report concerning the consequences of the earthquake in the city indicates about 570 buildings were collapsed and about 6000 others were damaged.

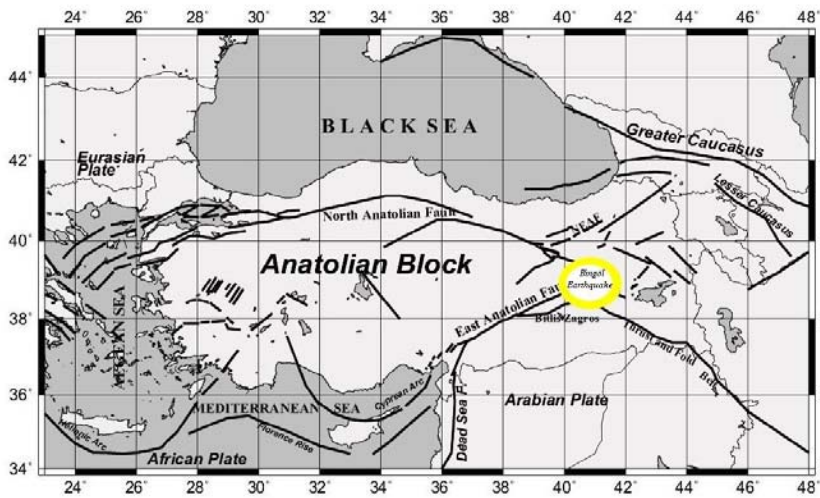

Figure 1: General tectonic setting of Turkey and Bingol earthquake location.

Many seismological centers have reported the earthquake. The parameters of the May 1 2003, Bingöl earthquake as given by KOERI, CSEM and USGS are presented in table 1.

Origin Time (U.T.)	*Coordinates Latitude*	*Longitude*	*Depth (km.)*	*Magnitude Mb*	*Ms*	*Mw*	*Md*	
00:27:04.0	39.01	40..46	10.0	6.0	6.4	6.4	6.2	ISK-Turkey
00:27:04.7	38.97	40.42	10.0			6.6		CSEM-French
00:27:04.9	38.99	40.46	25.0			6.4		USGS-USA

Table 1: Preliminary epicentral coordinates and magnitudes.

Seismotectonic setting

The tectonics of the region are controlled by collision of the Arabian and Eurasian plates. The northward motion of the Arabian plate relative to Eurasia causes lateral escape of the Anatolian block to the west and the Northeast Anatolian block to the east. The well-known active fault zones, namely the North Anatolian Fault (NAF), East Anatolian Fault (EAF) and associated conjugate faults surround the earthquake stricken area (Figure 1). The North Anatolian Fault is the most eminent tectonic feature of the region. It is an about 1500 km long, seismically active right lateral strike-slip fault system extending from the Karlıova triple junction in Eastern Turkey to mainland Greece.The East Anatolian Fault zone is a 550 km long, approximately north-east trending, left lateral strike-slip fault zone extending from the Karlıova triple junction in the northeast to the Maraş triple junction in the southwest were it intersects the Dead Sea Fault. Due to the presence of several active faults, the Bingöl-Karlıova- Erzincan triangle is the most important region where destructive earthquakes occur quite often. Some major earhtquakes occured on the East Anatolian Fault during the 20^{th} century. These are the December 26, 1939 (Ms= 7.9) Erzincan, May 22, 1971 (Ms= 6.8) Bingöl, March 13, 1992 (Ms= 6.8) Erzincan and January 27, 2003 (Ms= 6.2) Pülümür earthqaukes. Particularly, the epicenter of May 22, 1971 Bingöl earthquake is very close the present earthquke which is located at about 14 km N-NW of the Bingöl city (Eyidoğan et al., 1991 and Kalafat et al.,2000).

Field Observation

The preliminary field observations undertaken by the Dr Doğan Kalafat and Seismology Team.The epicentral location of the 2003 Bingöl earthquake is generally located in the Balıkçay-Hanoçayırı-Kurtuluş-Sudüğünü region (Kalafat et al., 2003). That agrees well with the NW-SE trending fault in the East Anatolian system and the intensity of this earthquake in the epicenter nearby is VIII (MSK). Numerous seismically induced ground deformations, fault traces, fault breaks in the surface, settlements and toppled rocks have been observed in the region (Figure 2). According to these observations, a few surface ruptures were located between Hanoçayırı and Sudüğünü villages at NW and SE that have a strike of N20°-30°W. However, a vertical drop of 40-65 cm in the western direction was observed in the field. Our preliminary observations support the idea that for the building stock in Bingol this was a near-field experience.

Figure 2. Surface break and ground deformation in the epicentral area.

Focal mechanism

In the Central station, seismological data are interpreted (P and S arrivals identification, first onsets, signal duration) and processed by computer. Figure 3 shows the original waveforms recorded at ISK Broadband station in Kandilli Observatory and calculated synthetic waveforms in three components. The fault plane solution indicated that the causative fault was a right-lateral strike slip fault (strike 153°, dip 88°). This fault plane coincides with the aftershock distribution and is believed to represent the actual fault plane. The seismic moment is Mo = 4.3 x 10^{18} Nm indicates a moment magnitude (Mw) of 6.4.

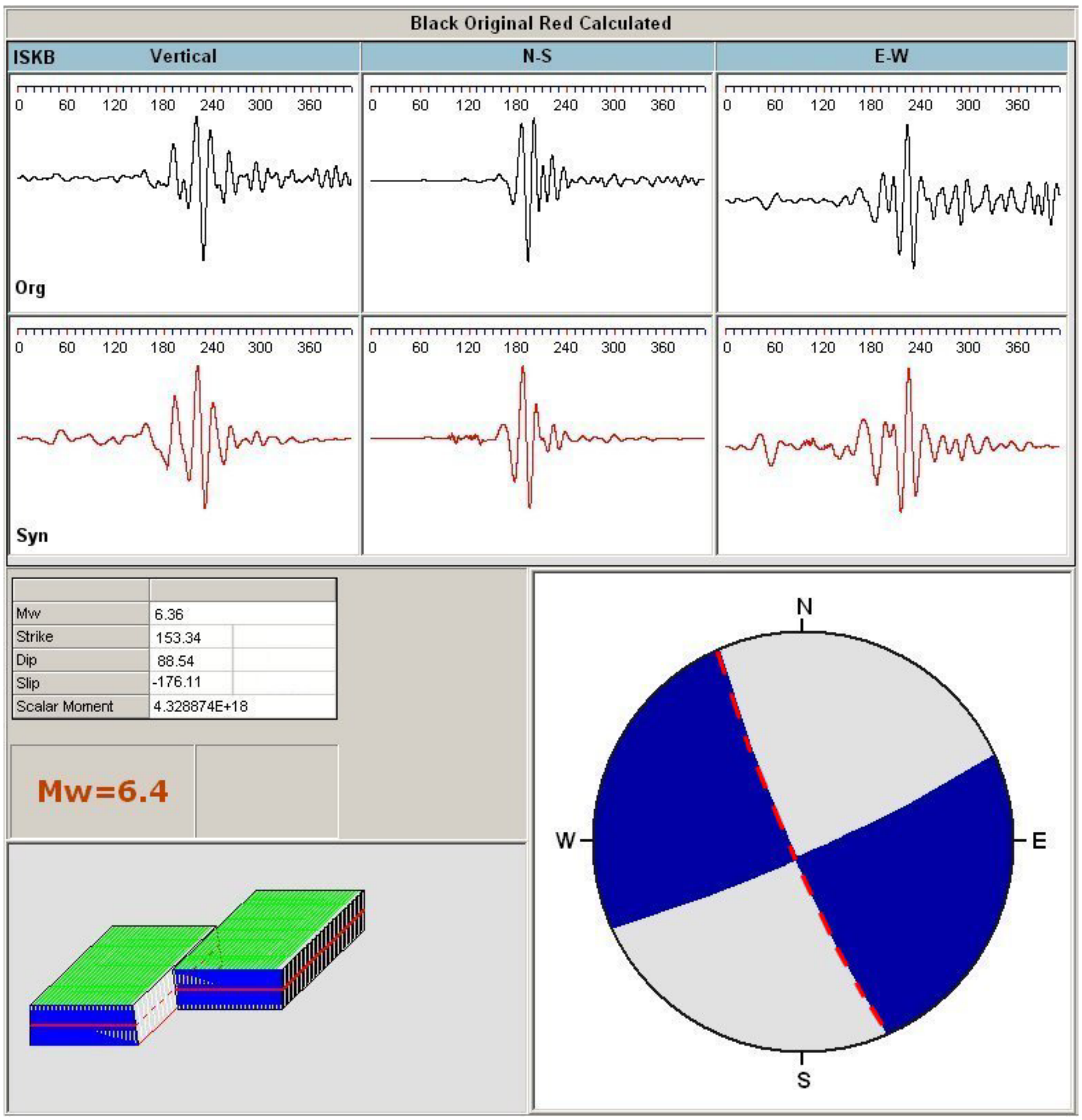

Figure 3. Focal mechanism solution of the mainshock.

Aftershock activity

Following the occurrence of the mainshock, a total of more 6700 aftershocks were recorded between 1-8 May, 2003 by Seismology Division (Figure 4). The number of aftershocks decreased with time. Aftershocks of 2003 Bingöl earthquake are generally located in Bingöl-Sancak-Adaklı region. The distribution of these earthquakes with days is illustrated in the following figure.

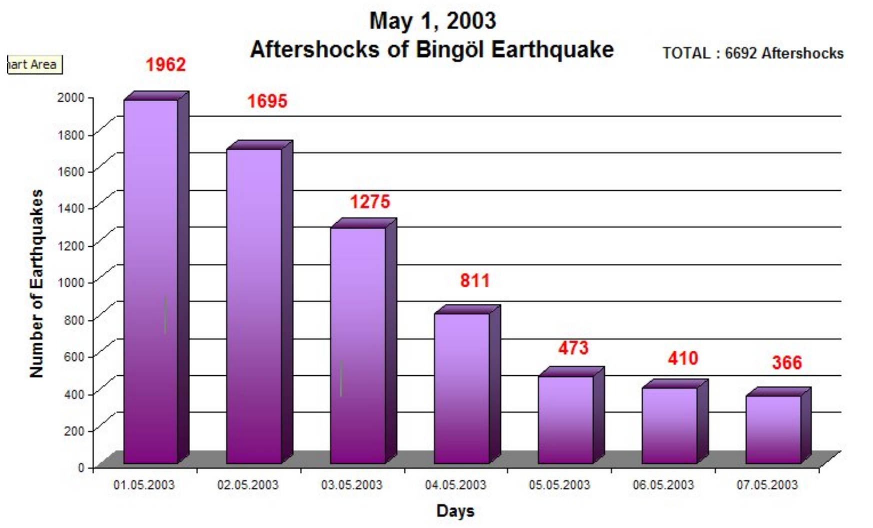

Figure 4. Distribution of aftershocks occurred between 01-08 May, 2003.

As seen from figure 5 the afterschocks with M≤ 4.3 took place over a large area around the epicenter of the main shock. Therefore, it is difficult to estimate an evident faulting strike from this distribution. However, based on the evaluation of the aftershocks with M ≥ 4.3, they show an alignment in NW- SE direction that is consistent with the fault break (Figure 6).

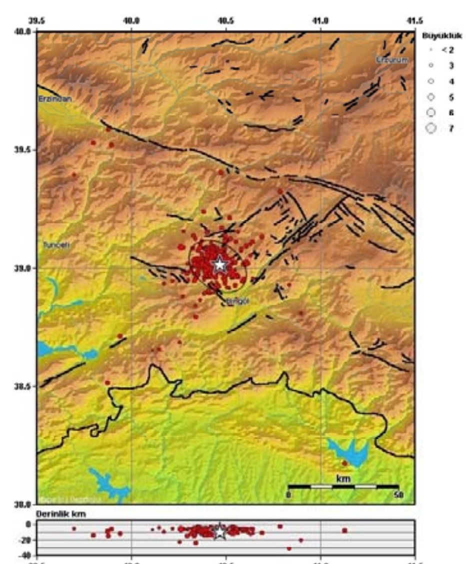

Figure 5. The aftershock activity with M ≤ 4.3.

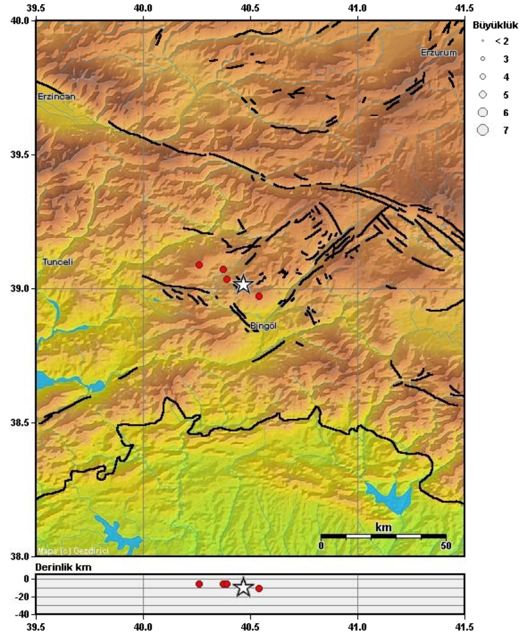

Figure 6. The aftershock activity with $M \geq 4.3$.

Conclusion

The Bingöl earthquake was strongly felt in Bingöl and its vicinity, causing panic amoung the people. The earthquake seriously damaged or destroyed a host of other buildings in Bingöl as well as public buildings (Figure 7) .The diffrences in damage to buildings from place to place in Bingol were a result of characteristics of the structures, not of foundation conditions or gross ground deformation of any kind. The damage was mainly due to poor quality of concrete, lack detailing of reinforcement steel and inappropriate construction practices. So, it should be aimed to promote the notion of seismic structural stability of buildings and infrastructure and thus better protect vulnerable people in the event of future disasters in Turkey.

Figure 7. Building damages in Bingöl city.

Acknowledgements

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