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The Earthquake Catalogues for Turkey

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Abstract: The earthquake data from instrumental records in the last 40 years indicate the general seismicity of the earth. However, examining historical records is necessary to understand long-term seismicity. Catalogue studies about historical earthquakes in Turkey are limited. All these catalogues are on printed paper and a digital database has not yet been prepared. On the other hand, there is no common database for the focal mechanism solutions of the recent destructive earthquakes (Mw≥5.5) in the region. The present study aims to prepare two new digital databases for earth scientists so that the earthquake parameters can be reached from a single source. The first one is 'The Historical Earthquake Catalogue of Turkey' which includes parameters of the earthquakes occurring between 2100 B.C. and 1963 A.D. This database contains approximately 2285 events and is presented as an electronic supplement. The second dataset, 'The Focal Mechanism Solutions Catalogue of Turkey', contains fault plane solution parameters of the destructive earthquakes occurring between 1938 and 2004. All available mechanism solutions of the destructive earthquakes were collected, although the global moment tensor solutions reported via the internet were not included in the present study.

Key Words: Turkey, historical earthquakes, focal mechanism solutions, earthquake catalogue

Türkiye Deprem Kataloğu

Özet: Son 40 yılda aletsel kayıtlardan elde edilen deprem verileri yeryüzünün günümüz depremselliğini genel anlamda ortaya çıkarmaya yeterli olmaktadır. Ancak, uzun dönemli depremselliğin anlaşılması için tarihsel kayıtların incelenmesi gerekmektedir. Türkiye'de meydana gelmiş tarihsel depremlerle ilgili katalog çalışmaları sınırlı düzeydedir. Katalogların tamamı kağıt ortamında mevcuttur ve henüz sayısal ortamda bir veri tabanı oluşturulmamıştır. Ayrıca bölgede meydana gelmiş güncel yıkıcı depremlerin (Mw≥5.5) odak mekanizması çözümleri için de ortak bir veri tabanı yoktur. Yerbilimcilerin bu verilere ortak bir kaynaktan ulaşabilmeleri amacıyla iki yeni sayısal veri tabanı oluşturulmuştur. Bunlardan ilki M.Ö. 2100 ile M.S. 1963 yılları arasında meydana gelen depremlerin parametrelerini içeren 'Türkiye Tarihsel Deprem Kataloğu'dur. Mevcut olan tüm yazılı kaynaklar kronolojik sırayla taranmıştır. Bir depreme ait parametre seçilirken ortak referansı en fazla olan değer dikkate alınmıştır. Oluşturulan bu katalog yaklaşık 2285 deprem içermektedir ve elektronik olarak sunulmaktadır. İkinci veri seti ise 1938–2004 yılları arasında meydana gelmiş yıkıcı depremlerin odak mekanizması çözümlerini içeren 'Türkiye Odak Mekanizması Çözümleri Kataloğu'dur. Bu katalog için mevcut olan tüm mekanizma çözümleri derlenmiştir. Ancak internet üzerinden erişilebilen moment tensör çözümleri veri tabanına dahil edilmemiştir.

Anahtar Sözcükler: Türkiye, tarihsel depremler, odak mekanizması çözümleri, deprem kataloğu

Introduction

Turkey, which is a natural laboratory for earth sciences, covers one of the most seismically active regions on the earth. The complex plate interaction among Arabia, Eurasia and Africa has created different fault systems in Anatolia and the surrounding region. The northward motion of the Arabian Plate has resulted in continental collision in Eastern Turkey and the Caucasus. Although thrust faults have been observed in the east, there are several active strike-slip fault segments that generate destructive earthquakes (Mw>5.5). The North Anatolian Fault System (NAFS) and the East Anatolian Fault System (EAFS) are the main strike-slip fault belts in Turkey. These fault systems facilitate the westward escape of the Anatolian micro-plate. Normal fault systems are dominant in western and central Anatolia because of the north-south extensional regime in the Aegean.

Earthquake data collected over the last 40 years indicate that most earthquakes occur in eastern and western Anatolia, and on the two main fault systems (NAFS and EAFS). Existing digital databases are inadequate to study the long-term seismicity and recurrence interval of the large earthquakes in the region, so more data needs to be collected in order to increase information about historical events. Cataloguing historical data is very important to access the earthquake information easily. For this purpose, in this study, two new digital datasets have been created on the earthquakes in Turkey. The first one is 'The Historical Earthquake Catalogue of Turkey', which includes parameters of the earthquakes occurring between 2100 B.C. and 1963 A.D. The second dataset is 'The Focal Mechanism Solutions Catalogue of Turkey' that includes faulting parameters of the destructive earthquakes occurring between 1938 and 2004.

Databases

The Historical Earthquake Catalogue of Turkey (2100 B.C. – 1963 A.D.)

There are several printed catalogues about historical earthquakes in Turkey and the surrounding area (Pınar & Lahn 1952; Ergin *et al.* 1967, 1971; Soysal *et al.* 1981; Güçlü *et al.* 1986; Ambraseys & Finkel 1995; Ambraseys & Jackson 1998). There are also some reports that cannot be accessed easily, so it is necessary to compile various catalogues and make a digital database.

Two important publications contain information about historical earthquakes in Turkey (Soysal *et al.* 1981; Ambraseys & Finkel 1995). Soysal *et al.* (1981) presented 1175 events occurring between 2100 B.C. and 1900 A.D. Ambraseys & Finkel (1995) gave details and maps about historical earthquakes of the region. However, some earlier reports became a basis for recent studies. The first one, prepared by Pınar & Lahn (1952), contains information about destructive earthquakes but gives no data on their coordinates and magnitudes. Ergin *et al.* (1967) compiled the first detailed catalogue according to accepted methods and recommended by the UNESCO Intergovernmental Meeting on Seismology and Earthquake Engineering (April 21–30, 1964, Paris, UNESCO/NS/SEISM/5). This catalogue includes epicentre coordinates and intensity of the events from 11 to 1964. The updated version of the catalogue was published by Ergin *et al.* (1971). The historical earthquakes of Turkey are also given in the databases of neighboring countries (i.e. Guidoboni *et al.* 1994; Papazachos *et al.* 1997; Shebalin & Tatevossian 1997; Kondorskaya & Ulomov 1999).

In this study, all the references are chronologically searched and all the available historical events were inserted into a new catalogue. All the previous publications reported only large events and most of them gave different parameters for the same earthquake. Therefore, while selecting parameters for an event, only the widely accepted values in different published catalogues were used. There are also many events having no magnitude. Ergin *et al.* (1967, 1971) presented only intensity values for the historical earthquakes using reported damage and gave no information for the magnitudes. The intensity-magnitude relation formula ($M^* = 0.592 I_0 + 1.63$) as given by İpek *et al.* (1965), used in other catalogues, was used also here to calculate approximate magnitude (M^*) from intensity (I_0).

All available parameters of the historical earthquakes between 34°–43°N and 25°–46°E were collected as shown in Figure 1. Because of approximately 2285 entries, the parameters could only be presented as an electronic supplement. The date, time, location, magnitude and depth information of the earthquakes are given in a single text file. Table 1 shows the column structure and the reference abbreviations in the database. The list was terminated at the end of 1963 because the ISC began to report earthquake information systematically from 1964 on. The USGS-NEIC also has a large database beginning from 1973. Boğaziçi University Kandilli Observatory and Earthquake Research Institute (KOERI), European-Mediterranean Seismological Centre (EMSC) and Engdhal *et al.* (1998) also give earthquake lists for the period of instrumental seismology. These databases can easily be reached via the Internet.

The Focal Mechanism Solutions Catalogue of Turkey (1938–2004)

Focal mechanism solutions are one of the important parts of active tectonic studies. Shida (Kyota University) first discovered a systematic distribution of the two senses of P-wave polarity in azimuth about epicenter (Kasahara 1981). Then, Byerly (1955) proposed a simple and quick graphical technique to use P-wave polarity data, in which all available P-wave up (compression) and down (dilatation) polarity readings from the station records are collected and plotted on a stereonet. The up and down polarity groups are divided by two perpendicular lines (fault and auxiliary planes). The power of solution depends on a high number of clear polarity around the

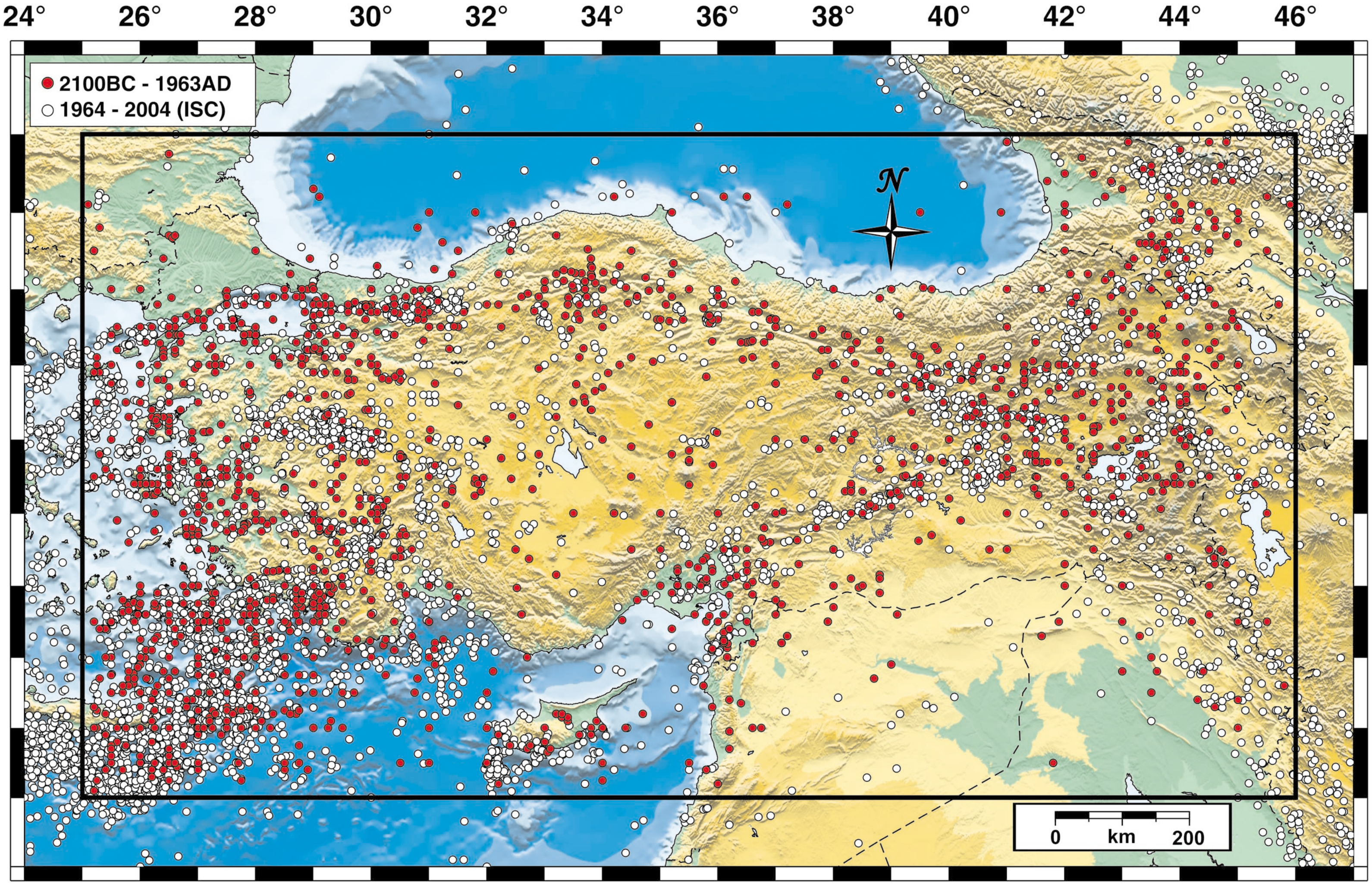

Figure 1. Seismicity map of Turkey. Red circles represent historical earthquakes given in the database. Present day earthquake activity (M≥ 4.0; ISC, 2001) is shown with white circles. The thick line is the boundary for the historical earthquake database.

Table 1. Description of the parameters in the historical earthquake database. A sample table is given below. The latitude and longitude of the events are given in the first and second columns. Calculated surface (Ms) and moment (Mw) magnitudes that were reported in the original reference are shown in the third and fourth columns. M refers to unknown magnitude type. M* represents magnitude which was calculated with the intensity relation formula (İpek *et al.* 1965). Column five is the depth of the event. The date and time are given in the sixth and seventh columns. The dates B.C. are represented with negative (-) sign. Column eight is the reference. AJ: Ambraseys & Jackson (1998); AJ2: Ambraseys & Jackson (2000); EG: Guidoboni *et al.* (1994); HS: Soysal *et al.* (1981); KE: Ergin *et al.* (1967, 1971); KU: Kondorskaya & Ulomov (1999); PA: Papazachos *et al.* (1997); ST: Shebalin & Tatevossian (1997).

Latitude (°)	Longitude (°)	Magnitude	Magnitude Type	Depth (km)	Date (yy mm dd)	Time (hhmmss)	Ref.
35.50	25.50				-2100		HS
35.50	25.50				-1890		HS
–	–	–	–	–	–	–	–
39.10	43.90	7.00	Ms	15.0	1695 04 15		ST
–	–	–	–	–	–	–	–
40.65	29.00	6.10	Mw	20.0	1903 05 26	0609	KU
–	–	–	–	–	–	–	–
34.10	24.90	5.18	M*		1938 01 02	105444	KE
–	–	–	–	–	–	–	–
38.40	45.30	4.50	M	33.0	1963 12 31	151808	KE

epicentre. Because the nearest stations to the earthquake source are located at the edge of the stereonet, the planes are confined, thus decreasing the error in the solution. The P-wave first motion polarity method lets us define only the strike and dip angles of the both nodal (fault and auxiliary) planes.

Computers have been used in earthquake wave analysis since the 1980s. By using computers, a seismologist can determine faulting parameters more accurately with complex mathematical models than ever before. Modelling shape and amplitude of waves improves observation details of the source parameters. For this purpose, P and S phases of earthquake waveforms from several stations are collected and analyzed with inversion techniques. Many parameters, such as strike, dip, rake, centroid depth and seismic moment can be found with earthquake waveform inversion. Energy release as a function of time, meaning rupture history of an earthquake, is also determined in that inversion method. Changes of synthetic waveforms give more realistic error values for faulting parameters.

Several focal mechanism solutions have been reported in various publications for the Turkish earthquakes. Therefore, researchers must search all of these for available solutions in their study area. When all the solutions are imported into a single database, a very useful resource is established for further studies. In this study, all available P-wave first motion and body waveform inversion solutions of the destructive earthquakes have been collected (Table 2, Figure 2). However, the global moment tensor solutions reported by Harvard University and USGS have not yet been included. These databases can be accessed on the web sites and solution details can be obtained from the ftp servers (http://www.globalcmt.org/; http://neic.usgs.gov/neis/sopar/).

Coordinate and time information for a given earthquake may have been reported differently in previous studies. As inconsistencies may arise due to different epicentre databases (i.e. ISC, USGS) or preliminary information, the ISC parameters are used in this study for all events in order to standardize the time and coordinate parameters. Nevertheless, the parameters of the earthquakes that occurred before 1964 were taken from the ISS (International Seismological Summary). The first and second nodal plane values are given in degrees and are in agreement with Aki & Richards (1980) convention. Most of the first motion solutions were not given according to Aki & Richards' convention. Additionally, some of the nodal planes were not perpendicular and rake angles were not reported in the publications. Also, several typographical errors were found in these papers. Hence, the parameters were changed by a few degrees to calculate both nodal planes but deranging tectonic meaning of the solution was not allowed. 74 first motion and 87 inversion solutions were collected for 108 earthquakes, occurring between 1938 and 2004. The faulting parameters are summarized in Table 2 and the lower hemisphere equal area projection plots are shown in Figure 3.

Table 2. The earthquake focal mechanism solution catalogue of Turkey (1938–2004). Time, latitude (Lat.), longitude (Lon.), body (m_b) and surface (M_s) magnitudes and focal depth (FD) of each event are from ISC database (ISC 2001). Strike (S), dip (D) and rake (R) values of 1st and 2nd nodal planes are given in degrees. h represents focal depth given by the author for the first motion solutions (FM) and centroid depth for the body waveform inversion solutions (I). Fault type according to the rake angels is also given (see the text). The last column is used for abbreviations for reference. *mul.* refers to focal mechanism solution of the multiple of that event. A86: Alptekin *et al.* (1986); AK00: Aktar *et al.* (2000); BN96: Braunmiller & Nábelek (1996); C72: Canıtez (1972); CT71: Canıtez & Toksöz (1971); Ca02: Çalışkan (2002); E99: Eyidoğan *et al.* (1999); EB96: Eyidoğan & Barka (1996); EJ85: Eyidoğan & Jackson (1985); F97: Fuenzalida *et al.* (1997); JK82: Jackson *et al.* (1982); JM84: Jackson & McKenzie (1984); K83: Kudo (1983); MK72: McKenzie (1972); MK78: McKenzie (1978); N84: Nábelek (1984); P91: Papazachos *et al.* (1991); PI98: Pınar (1998); R04: Roumelioti *et al.* (2004); S83: Şengör *et al.* (1983); T91a, b: Taymaz *et al.* (1991a, b); T92: Taymaz & Price (1992); T93: Taymaz (1993); T96: Taymaz (1996); T97: Taymaz (1997); T99: Taymaz (1999); Tan04: Tan (2004); TI01: Tibi *et al.* (2001); To78: Toksöz *et al.* (1978); TT99: Taymaz & Tan (1999); TT01a: Tan & Taymaz (2001); TT01b: Taymaz & Tan (2001);TT03a, b: Tan & Taymaz (2003a, b); TT04: Tan & Taymaz (2004); TT05: Tan & Taymaz (2005); TT06: Tan & Taymaz (2006); TTY04: Taymaz *et al.* (2004); U03: Utkucu *et al.* (2003); W99: Wright *et al.* (1999).

No	Date (dd mm yy)	Time (hh:mm:ss)	Lat. (°)	Lon. (°)	m_b	M_s	FD (Km)	S1 (°)	D1 (°)	R1 (°)	S2 (°)	D2 (°)	R2 (°)	h (Km)	Mo (10^{16}Nm)	Sol. Type	Fault Type	Ref.
1	19 04 1938	10:59:17	39.50	33.70	—	6.8	35	30	60	4	298	87	150	—	—	FM	LL	JM84
2	26 12 1939	23:57:16	39.70	39.70	—	8.0	35	108	86	151	200	61	4	—	—	FM	RLwR	MK72
3	20 06 1943	15:32:50	40.80	30.40	6.2	—	35	86	90	166	176	76	0	—	—	FM	RL	MK72
4	23 07 1949	15:03:30	38.60	26.30	6.8	—	—	250	56	-149	141	65	-38	—	—	FM	RLwN	MK72
5	13 08 1951	18:33:30	40.80	33.40	6.8	—	—	81	70	-172	348	83	-20	—	—	FM	RL	MK72
6	18 03 1953	19:06:13	40.00	27.30	7.1	—	—	150	84	14	59	76	174	—	—	FM	LL	MK72
7	16 07 1955	07:07:10	37.60	27.20	6.8	—	—	55	51	-133	292	55	-49	6	—	FM	NwRL	MK72
8	20 02 1956	20:31:37	39.90	30.40	6.0	—	—	140	56	-51	264	50	-133	9	—	FM	NwLL	MK72
9	24 04 1957	19:10:13	36.37	28.59	6.9	—	48	83	63	16	346	76	152	50	—	FM	LL	MK72
10	25 04 1957	02:25:42	36.47	28.56	7.1	—	53	58	85	19	325	71	174	0	—	FM	LL	MK72
11	26 05 1957	06:33:34	40.67	30.86	7.0	—	—	87	78	180	358	90	-12	0	—	FM	RL	MK72
12	25 04 1959	00:26:39	37.97	28.50	6.1	—	—	65	76	-70	188	24	-144	43	—	FM	NwLL	MK72
13	18 09 1963	16:58:08	40.80	29.13	6.2	—	—	118	20	-69	276	70	-97	33	—	FM	NwLL	MK72
								268	70	-125	152	40	-32	33	—	FM	NwRL	JM84
								304	56	-82	110	35	-102	15	96	I	N	T91a
14	14 06 1964	12:15:31	38.13	38.51	5.5	—	3	0	80	-90	180	10	-90	8	—	FM	N	MK72
								227	29	-28	342	77	-116	11	63	I	LLwN	T91b
15	06 10 1964	14:31:23	40.30	28.23	6.0	—	34	122	54	-90	302	36	-90	10	—	FM	N	MK72
								273	40	-95	101	44	-87	—	—	FM	N	P91
								110	40	-90	290	50	-90	14	410	I	N	T91a
16	13 06 1965	20:01:50	37.85	29.32	5.1	—	33	101	70	-90	281	20	-90	16	—	FM	N	MK72
								259	38	-90	79	62	-90	—	—	FM	N	P91
								102	67	-100	306	25	-68	—	—	FM	N	W93
17	23 08 1965	14:08:58	40.51	26.17	5.2	—	33	177	41	6	82	86	131	12	—	FM	LL	CT71
18	07 03 1966	01:16:08	39.20	41.60	5.2	—	26	310	60	143	60	58	36	38	—	FM	RLwR	MK72
								95	65	125	216	42	39	10	36	I	RwRL	T97
19	27 04 1966	19:48:51	38.14	42.52	4.9	—	28	195	67	-17	292	74	-156	40	—	FM	LL	MK72
20	19 08 1966	12:22:10	39.17	41.56	5.8	—	—	304	64	147	50	61	30	33	—	FM	RLwR	MK72
								100	65	130	217	46	36	10	833	I	RwRL	T97
21	20 08 1966	11:59:09	39.42	40.98	5.3	—	14	104	86	-166	13	76	-4	12	—	FM	RL	MK72
								100	90	177	190	87	0	10	159	I	RL	T97
22	10 12 1966	17:08:33	41.09	33.56	4.8	—	13	75	90	180	345	90	0	13	—	FM	RL	MK72
23	07 04 1967	18:33:31	37.36	36.24	4.9	—	32	0	90	-90	180	0	-90	39	—	FM	N	MK72
								47	80	-62	156	30	-159	39	—	FM	NwLL	JM84
24	22 07 1967	16:56:58	40.67	30.69	6.0	—	—	93	90	180	3	90	0	4	—	FM	RL	MK72

Table 2. (Continued)

No	Date (dd mm yy)	Time (hh:mm:ss)	Lat. (°)	Lon. (°)	m_b	M_s	FD (Km)	S1 (°)	D1 (°)	R1 (°)	S2 (°)	D2 (°)	R2 (°)	h (Km)	Mo (10^{16}Nm)	Sol. Type	Fault Type	Ref.
								278	88	-175	188	85	-2	—	—	FM	RL	C72
								275	88	-178	185	88	-2	12	7500	I	RL	T91a
25	26 07 1967	18:53:01	39.54	40.38	5.6	—	—	102	84	162	194	72	6	33	—	FM	RL	MK72
								101	86	-164	10	74	-4	14	—	FM	RL	CT71
								100	75	-165	6	76	-16	8	65	I	RL	T97
26	30 07 1967	01:31:01	40.72	30.52	5.4	—	18	151	44	-67	301	50	-110	16	—	FM	NwLL	MK72
27	29 04 1968	17:01:55	39.24	44.23	5.3	—	17	59	70	26	320	66	158	34	—	FM	LLwR	MK72
28	03 09 1968	08:19:52	41.81	32.39	5.7	—	5	210	65	139	320	54	32	5	—	FM	RLwR	MK72
								196	82	158	284	68	7	—	—	FM	RLwR	Ş83
								232	74	163	326	73	16	—	—	FM	RL	K83
								213	68	153	315	66	25	5	—	FM	RLwR	JM84
								28	38	80	221	53	98	4	390	I	R	A86
								26	40	75	225	52	102	4	400	I	R	TT99
29	14 01 1969	23:12:06	36.11	29.19	5.6	—	22	100	74	82	306	18	115	33	—	FM	R	MK72
30	03 03 1969	00:59:10	40.08	27.50	5.6	—	—	219	65	45	107	50	147	4	—	FM	LLwR	MK72
								60	40	68	268	53	107	5	50	I	RwLL	T91a
31	23 03 1969	21:08:42	39.14	28.48	5.6	—	9	70	46	-117	287	50	-64	12	—	FM	NwRL	MK72
								112	34	-90	292	56	-90	8	98	I	N	EJ85
32	25 03 1969	13:21:34	39.25	28.44	5.5	—	37	90	40	-104	288	51	-79	23	—	FM	N	MK72
								90	40	-104	288	51	-79	8	170	I	N	EJ85
33	28 03 1969	01:48:29	38.55	28.46	5.9	—	4	101	61	-90	281	29	-90	9	—	FM	N	MK72
								281	34	-90	101	56	-90	—	2000	I	N	EJ85
34	06 04 1969	03:49:33	38.47	26.41	5.6	—	16	116	60	-90	296	30	-90	14	—	FM	N	MK72
35	30 04 1969	20:20:32	39.12	28.52	5.0	—	8	292	46	-65	78	49	-114	9	—	FM	NwRL	MK72
36	28 03 1970	21:02:23	39.21	29.51	6.0	—	18	128	55	-90	308	35	-90	20	—	FM	N	MK78
								280	30	-90	100	60	-90	10	—	FM	N	P91
								308	35	-90	128	55	-90	10	8750	I	N	EJ85
37	28 03 1970	23:11:43	39.15	29.56	4.8	—	31	77	33	-107	277	58	-79	37	—	FM	N	MK78
								133	49	-84	304	41	-97	8	51	I	N	BN96
38	16 04 1970	10:42:22	39.02	29.91	5.4	—	31	280	31	-100	112	60	-84	9	—	FM	N	MK78
								280	31	-100	112	60	-84	8	27	I	N	EJ85
39	19 04 1970	13:29:36	39.03	29.76	5.5	—	18	104	24	-90	284	66	-90	20	—	FM	N	MK78
								284	66	-90	104	24	-90	8	194	I	N	EJ85
40	23 04 1970	09:01:26	39.13	28.65	5.2	—	28	77	50	-96	267	40	-82	18	—	FM	N	MK78
41	12 05 1971	06:25:15	37.64	29.72	5.5	—	30	222	42	-107	64	50	-75	23	—	FM	N	MK78
								68	40	-90	247	50	-90	10	—	FM	N	P91
								230	35	-105	68	56	-80	12	60	I	N	T92
42	12 05 1971	10:10:37	37.60	29.68	5.3	—	36	214	90	-90	34	0	-90	33	—	FM	N	MK78
								73	14	-90	253	76	-90	10	—	FM	N	P91
43	12 05 1971	12:57:24	37.58	29.60	5.3	—	33	210	75	-90	30	15	-90	33	—	FM	N	MK78
								79	22	-72	241	70	-97	10	—	FM	N	P91
								235	65	-89	53	25	-92	12	25	I	N	T92
44	22 05 1971	16 43 59	38.85	40.52	5.9	—	3	232	86	-8	323	82	-176	3	—	FM	LL	JM84
								231	82	3	141	87	172	9	580	I	LL	T91b

Table 2. (Continued)

No	Date (dd mm yy)	Time (hh:mm:ss)	Lat. (°)	Lon. (°)	m_b	M_s	FD (Km)	S1 (°)	D1 (°)	R1 (°)	S2 (°)	D2 (°)	R2 (°)	h (Km)	Mo (10^{16}Nm)	Sol. Type	Fault Type	Ref.
45	25 05 1971	05:43:26	39.05	29.71	5.7	—	16	95	37	-109	298	55	-76	24	—	FM	N	MK78
								298	55	-77	96	37	-108	6	95	I	N	EJ85
46	14 03 1972	14:05:46	39.32	29.47	5.3	—	38	277	55	-92	101	35	-87	33	—	FM	N	MK78
No	Date (dd mm yy)	Time (hh:mm:ss)	Lat. (°)	Lon. (°)	mb	Ms	FD (Km)	S1 (°)	D1 (°)	R1 (°)	S2 (°)	D2 (°)	R2 (°)	h (Km)	Mo (1016Nm)	Sol. Type	Fault Type	Ref.
47	27 03 1975	05:15:07	40.45	26.12	5.5	—	—	41	60	-128	279	46	-43	5	—	FM	NwRL	MK78
								68	55	-145	316	62	-41	15	200	I	RLwN	T91a
48	30 04 1975	04:28:57	36.19	30.74	5.6	—	61	72	60	74	283	33	116	56	—	FM	R	MK78
49	06 09 1975	09:20:11	38.51	40.77	6.0	—	32	244	54	54	114	50	128	10	—	FM	RwLL	JM84
								270	50	50	143	54	127	5	1000	I	RwLL	N84
50	24 11 1976	12:22:15	39.05	44.04	6.1	—	10	342	86	168	73	78	4	800	—	FM	RL	To78
								115	74	174	206	84	16	36	—	FM	RL	JM84
								113	76	-178	23	88	-14	6	3600	I	RL	T97
51	25 03 1977	02:39:58	38.58	40.03	5.0	—	29	232	86	-8	323	82	-176	21	—	FM	LL	JM84
52	26 05 1977	01:35:13	38.93	44.38	5.2	—	38	38	90	-20	128	70	180	37	—	FM	LL	JM84
53	01 06 1977	12:54:49	36.16	31.30	5.6	—	68	30	90	0	120	90	180	67	—	FM	LL	JM84
54	05 10 1977	05:34:43	41.02	33.57	5.3	—	10	258	80	178	348	88	10	33	—	FM	RL	JM84
								70	65	155	171	67	27	8	58	I	RLwR	TT99
55	16 12 1977	07:37:29	38.41	27.19	5.3	—	24	90	28	-116	300	62	-76	34	—	FM	NwRL	JK82
56	28 05 1979	09:27:33	36.46	31.72	5.8	5.3	111	256	78	-90	76	12	-90	98	—	FM	N	JM84
57	14 06 1979	11:44:45	38.79	26.57	5.9	5.7	15	266	36	-105	104	56	-80	23	—	FM	N	JK82
								262	41	-108	105	51	-75	8	67	I	N	T91a
58	31 12 1979	06:21:35	36.22	31.49	5.3	4.9	93	140	80	90	320	10	90	79	—	FM	R	JM84
59	27 09 1983	23:59:39	36.72	26.93	5.4	—	160	261	20	122	49	73	80	160	—	FM	RwRL	P91
60	30 10 1983	04:12:28	40.35	42.18	6.0	6.8	16	215	64	7	122	84	154	9	800	I	LL	E99
								220	52	5	127	86	142	9	950	I	LL	TT06
61	30 10 1983	12:40:25	40.45	42.17	5.3	5.1	31	240	87	-11	331	79	-177	6	12	I	LL	E99
62	18 09 1984	13:26:02	40.90	42.24	5.3	5.5	10	204	81	11	112	79	171	9	14	I	LL	E99
63	18 10 1984	09:46:21	40.79	42.48	5.3	5.2	19	261	58	54	135	47	133	10	8	I	RwLL	E99
64	05 05 1986	03:35:38	38.02	37.79	5.7	5.8	4	273	49	31	161	67	135	4	112	I	LLwR	T91b
65	06 06 1986	10:39:47	38.01	37.91	5.5	5.6	11	275	27	30	158	77	114	2	90	I	LLwR	T91b
66	11 10 1986	09:00:10	37.94	28.56	5.4	5.4	5	275	35	-70	71	57	-103	15	17	I	NwLL	T93
67	20 04 1988	03:50:05	39.11	44.12	5.1	5.1	48	106	70	-164	10	75	-21	5	7	I	RL	TT04
68	25 06 1988	16:15:38	38.50	43.07	5.3	5.0	49	87	44	134	214	60	56	14	15	I	RwRL	TT04
69	27 04 1989	23:06:52	37.04	28.17	5.3	5.0	12	106	33	-70	263	59	-103	14	6	I	NwLL	TTY04
70	28 04 1989	13:30:20	37.03	28.11	5.1	5.1	17	91	35	-97	280	55	-85	8	16	I	N	TTY04
71	18 07 1990	11:29:26	37.00	29.57	5.1	4.9	26	66	52	-114	282	44	-62	8	13	I	NwRL	TTY04
72	13 03 1992	17:18:39	39.72	39.63	6.1	6.8	23	122	63	-164	25	76	-28	9	1050	I	RL	F97
								128	78	-170	33	80	-12	12	1475	I	RL	T96
73	15 03 1992	16:16:25	39.53	39.93	5.4	5.8	29	256	61	57	129	43	134	4	70	I	RwLL	F97
								240	65	35	134	59	150	5	65	I	LLwR	T96
74	06 11 1992	19:08:10	38.11	26.95	5.5	6.0	17	255	85	-158	163	68	-5	13	153	I	RLwN	TT01a

Table 2. (Continued)

No	Date (dd mm yy)	Time (hh:mm:ss)	Lat. (°)	Lon. (°)	m_b	M_s	FD (Km)	S1 (°)	D1 (°)	R1 (°)	S2 (°)	D2 (°)	R2 (°)	h (Km)	Mo (10^{16}Nm)	Sol. Type	Fault Type	Ref.
75	28 01 1994	15:45:25	38.69	27.50	5.2	5.1	10	259	43	-121	119	54	-64	8	15	I	NwRL	TTY04
76	24 05 1994	02:05:36	38.69	26.53	5.0	5.2	10	273	48	-122	136	51	-60	13	16	I	NwRL	TTY04
77	13 11 1994	06:56:01	36.92	29.05	4.9	4.9	10	138	55	-66	280	42	-120	12	8	I	NwLL	TTY04
78	01 10 1995	15:57:12	38.06	30.15	5.8	6.1	5	135	40	-105	334	52	-78	8	38	I	N	EB96
								309	51	-94	135	39	-85	10	210	I	N	PI98
								136	43	-87	312	47	-93	4	310	I	N	W99
								113	41	-119	329	55	-67	8	185	I	NwRL	TTY04
								130	39	-86	305	51	-93	6	166	mul.	N	
79	05 12 1995	18:49:32	39.43	40.11	5.3	5.7	26	134	76	155	230	66	15	13	46	I	RLwR	TT03b
80	02 04 1996	07:59:24	37.84	26.97	5.2	5.0	11	269	46	-125	134	54	-59	9	9	I	NwRL	TT03a
81	22 01 1997	17:57:23	36.19	35.94	5.3	5.5	45	217	19	-16	322	85	-108	4	89	I	LL	Ca02
82	04 04 1998	16:16:49	38.10	30.15	4.9	4.6	19	154	45	-74	311	47	-106	6	9	I	N	TTY04
83	13 04 1998	15:14:32	39.31	41.07	4.8	4.8	15	95	70	170	188	81	20	10	6	I	RL	Tan04
84	27 06 1998	13:55:54	36.85	35.33	5.5	6.1	47	50	85	10	319	80	175	33	363	I	LL	AK00
								51	77	17	317	73	166	20	292	I	LL	Tan04
85	25 07 1999	06:56:54	39.33	27.98	4.9	4.9	15	255	60	-156	152	69	-32	9	4	I	RLwN	TTY04
86	17 08 1999	00:01:39	40.76	29.96	6.1	7.7	17	270	83	-179	180	89	-7	?	14700	I	RL	TI01
								92	89	-177	2	87	-1	9	12000	I	RL	T99
87	13 09 1999	11:55:28	40.75	30.08	5.6	5.7	10	260	27	162	6	82	64	12	42	I	RL	T99
88	05 10 1999	00:53:28	36.75	28.24	4.8	4.7	17	55	48	-75	213	44	-106	15	13	I	N	TTY04
89	11 11 1999	14:41:23	40.75	30.25	5.4	5.5	7.5	294	40	174	29	86	50	17	35	I	RL	T99
90	12 11 1999	16:57:20	40.81	31.19	6.2	7.4	10	263	62	-176	171	86	-28	?	4700	I	RL	TI01
								276	59	-167	179	79	-32	14	4500	I	RL	T99
91	03 12 1999	17:06:54	40.41	42.36	5.3	5.5	13	226	73	1	136	89	163	6	27	I	LL	TT06
92	21 04 2000	12:23:09	37.88	29.36	4.8	4.8	20	316	72	-75	96	23	-128	6	6	I	N	TTY04
93	06 06 2000	02:41:50	40.70	32.98	5.5	6.0	10	2	46	-29	113	70	-132	8	130	I	LLwN	TT01b
								358	47	-30	109	69	-133	8	100	I	LLwN	U03
94	15 11 2000	15:05:37	38.41	42.95	5.2	5.4	48	100	64	111	239	33	54	18	38	I	RwRL	Tan04
95	15 12 2000	16:44:47	38.40	31.33	5.1	5.8	10	294	40	-80	101	51	-98	8	130	I	N	TTY04
96	25 06 2001	13:28:48	37.19	36.23	5.3	4.8	10	169	50	-94	355	40	-85	4	14	I	N	Tan04
97	03 02 2002	07:11:31	38.52	31.20	5.6	6.4	22	295	69	-60	57	36	-142	7	401	I	NwLL	TTY04
								258	49	-62	39	48	-118	7	342	mul.	NwLL	
								315	74	-49	63	46	156	19	75	I	NwLL	R04
								275	54	-43	34	57	-135	8	315	mul.	LLwN	
98	03 02 2002	09:26:46	38.63	30.88	5.6	5.6	25	37	50	-75	194	42	-107	10	69	I	N	TTY04
99	27 01 2003	05:26:23	39.48	39.85	5.5	6.0	10	60	71	-13	154	78	-161	10	132	I	LL	Tan04
100	10 04 2003	00:40:16	38.25	26.89	5.3	5.5	11	70	85	165	161	75	5	8	42	I	RL	TT03a
101	01 05 2003	00:27:05	39.00	40.46	5.7	6.3	10	336	80	-178	246	88	-10	10	318	I	RL	TT04
102	06 07 2003	19:10:28	40.45	26.04	5.1	5.5	17	170	80	10	78	80	170	6	46	I	LL	TTY04
103	13 07 2003	01:48:22	38.27	38.98	5.3	5.3	13	55	75	6	323	84	165	6	15	I	LL	Tan04
104	25 03 2004	19:30:48	39.93	40.88	5.0	5.4	10	188	84	15	96	75	174	12	16	I	LL	Tan04
105	28 03 2004	03:51:09	39.95	40.96	5.2	5.3	5	183	76	29	85	62	164	7	13	I	LLwR	Tan04
106	11 08 2004	15:48:25	38.34	39.25	5.3	5.4	7	66	80	-5	157	85	-170	4	23	I	LL	TT05
107	03 08 2004	13:11:31	36.86	27.78	4.8	4.5	10	67	39	-99	258	52	-82	11	5	I	N	TTY04
108	04 08 2004	03:01:06	36.84	27.78	5.2	5.1	10	50	39	-105	249	53	-78	7	17	I	N	TTY04

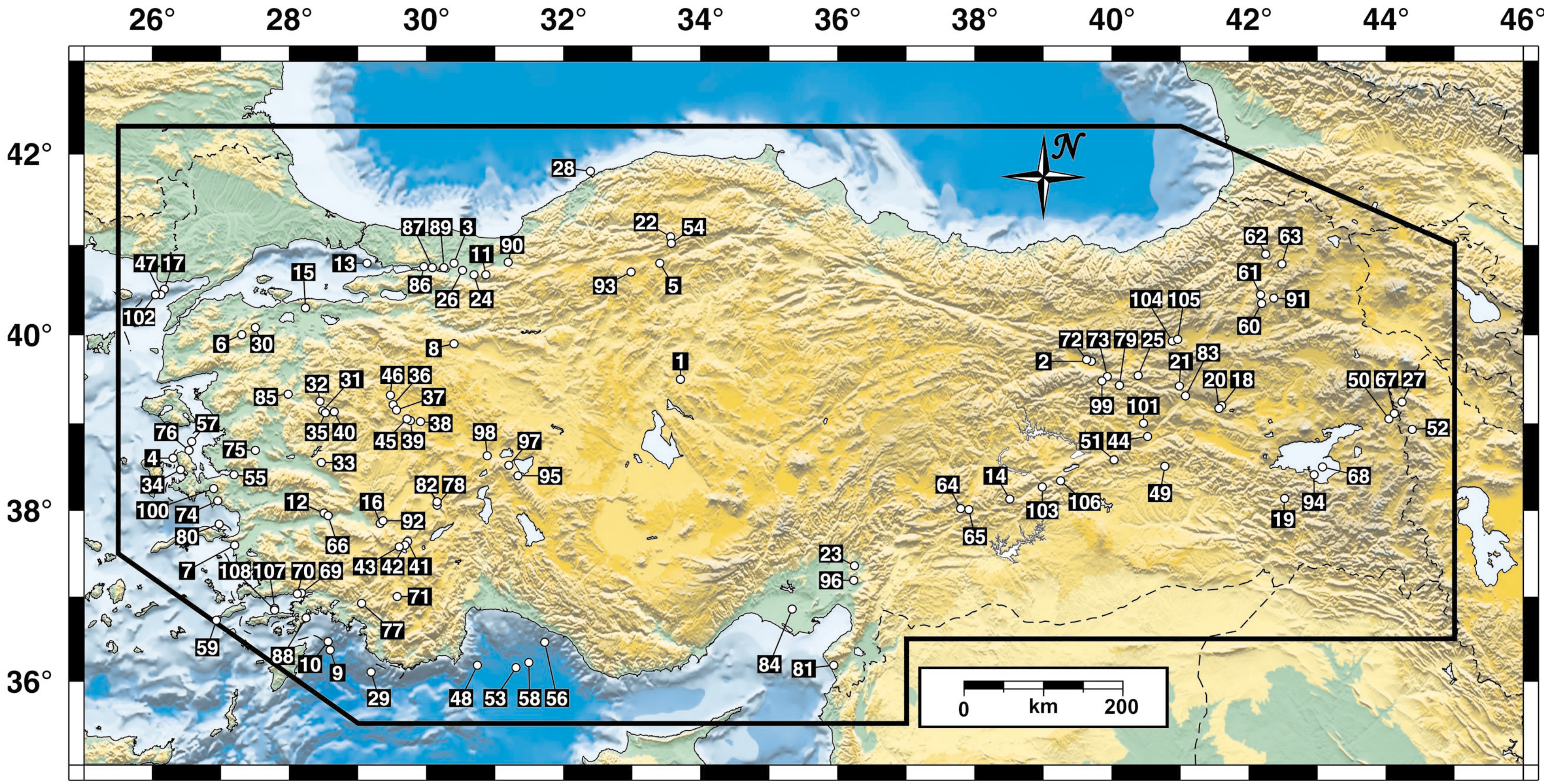

Figure 2. Locations of the earthquakes given in the focal mechanism solution catalogue. Numbers refer to the events in Table 2. The thick line is the boundary for the database.

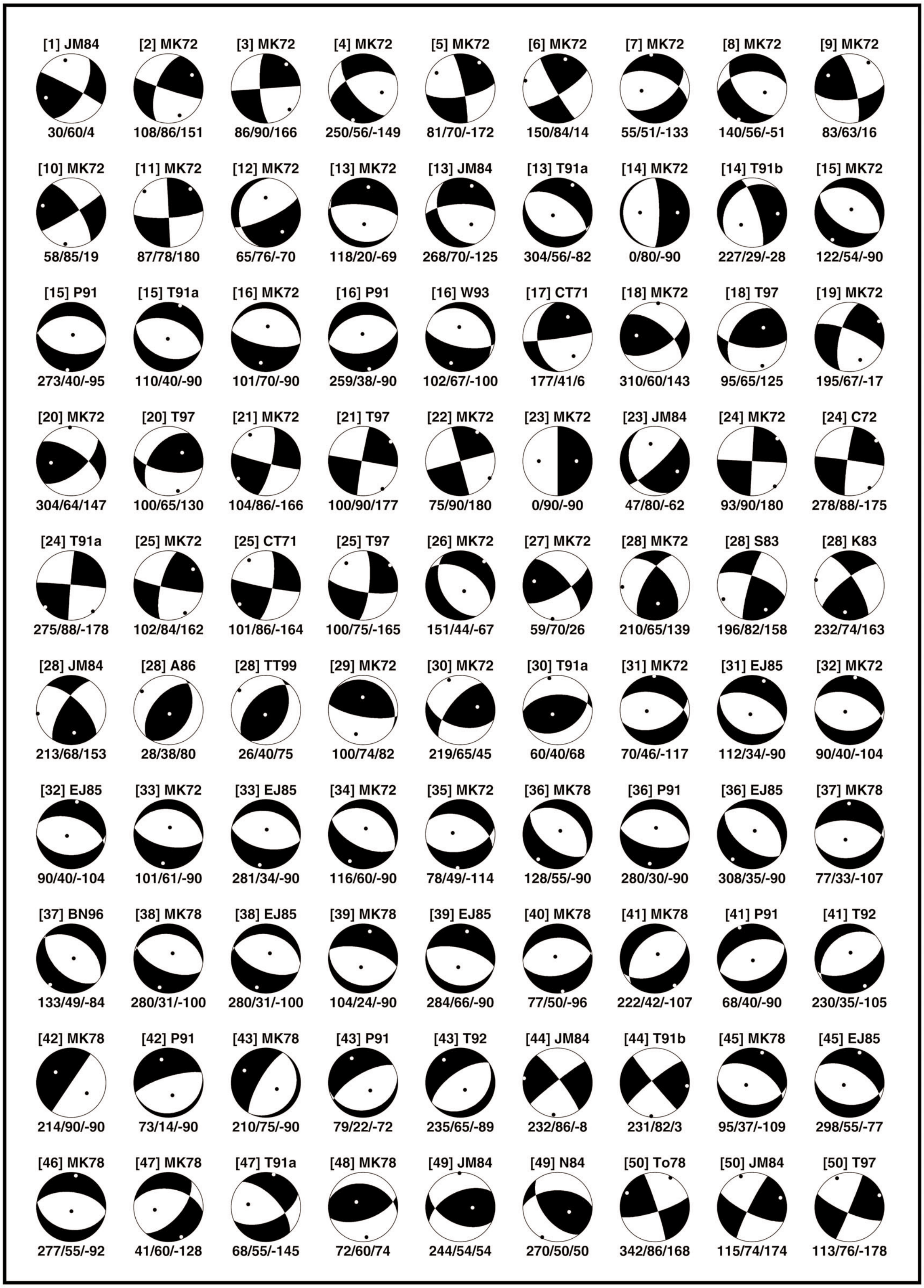

Figure 3. Lower hemisphere equal area projection plots of the focal mechanism solutions of earthquakes in Table 2. The shaded parts are compressional quadrants. Pressure (P) and tension (T) axes are plotted with black and white circles respectively. Event number (in brackets) and reference abbreviation are given above focal sphere. The strike, dip and rake values of the first nodal plane are below.

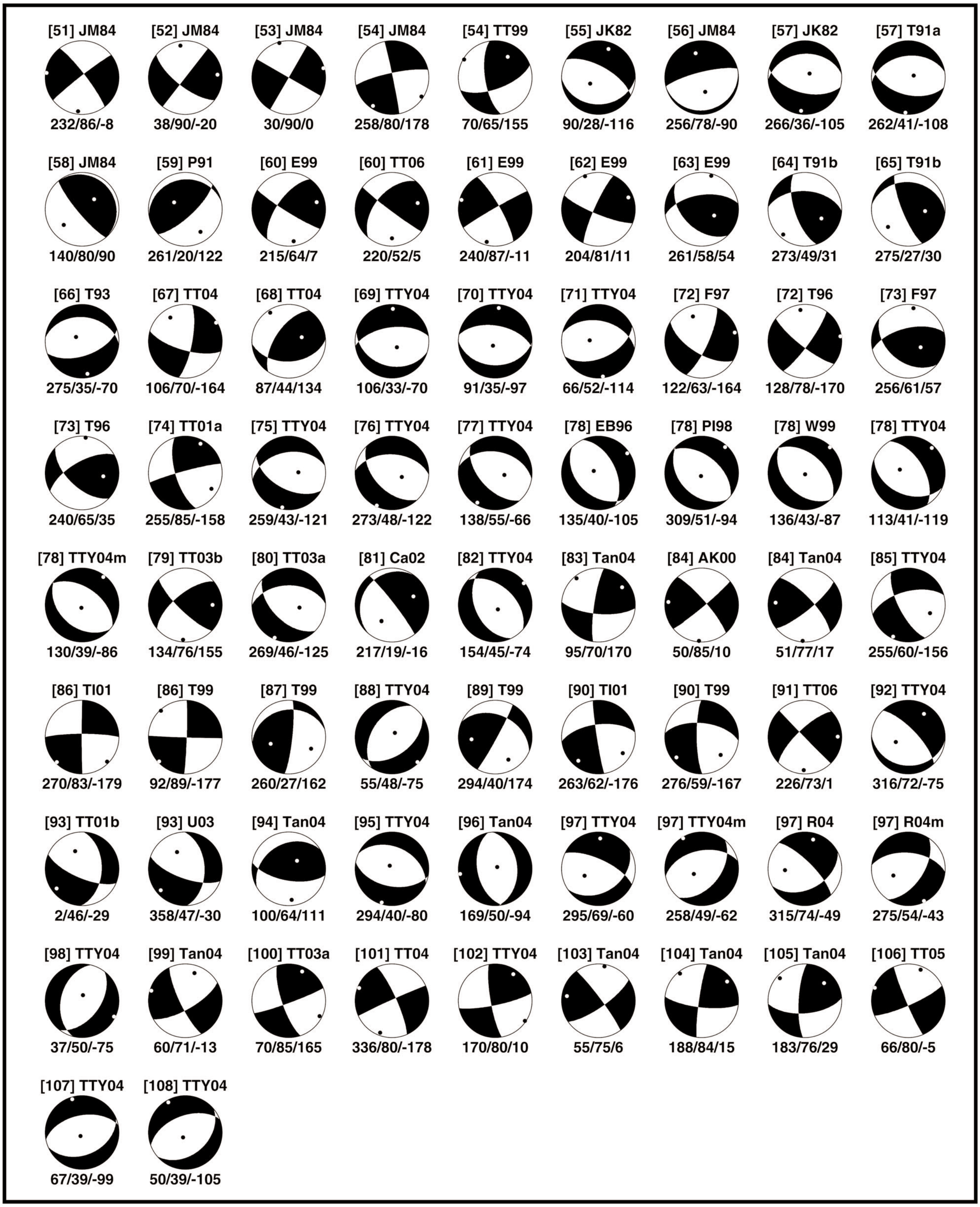

Figure 3b. (Continued)

Faulting types according to the rake angles of the first nodal plane (*R1*) are also given in the 18th column of the table to help researchers. Left-lateral, right-lateral, normal and reverse faulting are abbreviated as LL (*R1=0°*), RL (*R1=180°*), N (*R1=-90°*) and R (*R1=90°*) respectively according to the Aki & Richards' convention. Oblique faulting is named with combination of the main types (i.e. RLwR means right-lateral strike-slip fault with reverse component). Where the rake of the first nodal plane differentiates ±20° from the main faulting value the fault is defined as oblique. For example, rake angle range is -20°≤*R1*≤+20° (0°±20°) for a left-lateral fault (LL) and +21°≤*R1*≤+45° is for a left-lateral strike-slip fault with reverse component (LLwR). A normal fault with right-lateral component (NwRL) is limited to -135°≤ *R1*<-110°. It is difficult to give an exact angle limit but ±20° gives a good and practical approximation for defining and reporting the faulting mechanism.

Discussions and Conclusions

There have been fewer than 30 earthquakes in Turkey larger than magnitude 6.0 in the last 40 years. When smaller events (M≥4.0) are considered, it can be seen that they cluster in the western and eastern parts of Anatolia (Figure 1). Note that, based on Figure 1, the North Anatolian Fault System displays very low activity. However, it is well known that the fault system is capable of generating destructive earthquakes and there have been six large events (M≥6.5) between 1939 and 1957. Hence, the observations in the modern instrumental period of seismology in Turkey are insufficient to understand the behaviour of the fault systems. Researchers should mention the historical events. The earliest historical records are very sparse and locations given may be questionable. There have been only 35 events before Christ, and the seven events between 2100 and 1400 B.C. were very close to Crete. In Anatolia there have been no reported events in the records before 600 B.C.

The earliest focal mechanism solution was reported for the 1938 Kırşehir-Keskin earthquake, which was the single large event in Central Anatolia (Jackson & McKenzie 1984). After McKenzie (1972), focal mechanism studies became a very powerful tool in understanding the faulting properties of the Turkish earthquakes. The solutions for more than hundred earthquakes were reported by several researchers, but the data from these studies are unavailable.

The catalogues constitute important base information for future researches. With this aim, the first digital database about earthquakes in Turkey has been established. The parameters of the historical earthquakes and the focal mechanism parameters of 108 destructive earthquakes have been compiled in this database. These datasets reported here are believed to facilitate and enhance future earthquake studies.

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