NEOTECTONICS AND SEISMICITY OF THE ANKARA REGION: A CASE STUDY IN THE URUŞ AREA

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Approval of the Graduate School of Natural and Applied Science.

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ABSTRACT

NEOTECTONICS AND SEISMICITY OF ANKARA:
A CASE STUDY IN THE URUŞ AREA

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Study area, the Uruş province, is located 70 km WNW of city of Ankara. Major settlements in the study area are two counties, Uruş and Güdül; and there are a number of villages, such as, from W to E, Macun, Yoğunpelit, Kabaca, Üreğil, Özköy, Tahtacıörencik, Kırkkavak, Kavaközü, Kayı and Karacaören. The study area is 189 km^2 in size and included in 1/25000-scaled topographic quadrangles of H28a_3, a_4, d_1 and d_2. The Güdül-Uruş section of the Çeltikçi morphotectonic depression (Çeltikçi Basin) drained by the Antecedent Kirmir River and its second-order drainage system was first mapped in detail in the present study, and faults determining northern margin of the Çeltikçi depression were named as the Uruş fault set comprising the SW part of the Çeltikçi Fault Zone; and the mechanism of the master fault of the Uruş fault set was determined as left lateral oblique-slip fault with reverse component by the morphologic markers such as the deformed drainage system and pressure ridges. This was also supported by the fault plane solutions of the 2000.08.22 Uruş earthquake.

Three fault plane solutions, of which two of them for the 2000.08.22 Uruş earthquake, and one of them for the 2003.02.27 Çamlıdere earthquake, were done to determine nature of the source.

Ground material underlying the city of Ankara were divided into three categories: (a) well-lithified basement rocks, (b) Pliocene fluvio-lacustrine sedimentary sequence, and (c) unconsolidated terrace and alluvial sediments of Quaternary age. Quaternary unconsolidated sediments are densely populated in Ankara. These sediments are fine-grained and have a maximum thickness of 200 m or more. Inside these sediments, static ground water level is very close (as on average: 6 m) to ground surface. These conditions are quite suitable for liquefaction of these unconsolidated alluvial sediments. In addition, basement rocks are full of zone of weakness. Even if, the city of Ankara is characterized by the shallow focus and small earthquakes (M≤5), it is open to the risk of large earthquakes to be sourced from the North Anatolian Fault System and the Seyfe Fault Zone located 110 km and 80 km, respectively, owing the ground material conditions beneath the city of Ankara. This point has to be taken out in constructions and site selection solution.

Key words: neotectonic, seismicity, Uruş fault set, Uruş earthquake, Çamlıdere earthquake, fault plane solution, ground material

ÖZ

ANKARA'NIN NEOTEKTONİĞİ VE DEPREMSELLİĞİ ve URUŞ CİVARINI KAPSAYAN ÇALIŞMA

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Çalışma alanı, Uruş yerleşkesi, Ankara'nın 70 km BKB sında bulunmaktadır. Alan Uruş ve Güdül olmak üzere başlıca 2 yerleşkeyi ve batıdan doğuya doğru Macun, Yoğunpelit, Kabaca, Üreğil, Özköy, Tahtacıörencik, Kırkkavak, Kavaközü, Kayı ve Karacaören köylerini içermektedir. 189 km^2 lik çalışma alanı 1/25000 ölçekli topografik haritaların $H28a_3$, a_4, d_1 ve d_2 paftalarını kapsamaktadır. Çeltikçi morfolojik çöküntüsünün Güdül-Uruş bölümü antesedan Kirmir Nehri tarafından kazılmış ve ikincil drenaj sistemi ilk kez bu çalışma kapsamında detaylı olarak haritalanmıştır. Çeltikçi çöküntüsünün kuzey kenarını belirleyen faylar Uruş fay seti olarak adlandırılmış ve Çeltikçi Fay Zonu içerisinde değerlendirilmişlerdir. Deforme olmuş drenaj sistemleri ve basınç sırtı gibi morfolojik faktörler göz önünde bulundurulduğunda Uruş Fay Seti'nin ana fayı sol yanal yönlü ters bileşenli oblik fay olarak belirlenmiştir. Bu sonuç aynı zamanda 22.08.2000 tarihli Uruş depreminin mekanizma çözümleriyle desteklenmiştir.

İki tanesi 22.08.2000 Uruş depremi ve bir tanesi 27.02.2003 Çamlıdere depremine ait olmak üzere üç tane fay düzlemi çözümü kaynağın doğasını belirlemek için yapılmıştır.

Ankara zemini üç kategoriye ayrıldı: (a) sert zemin kayaları (b) Pliosen karasal göl sedimanter istifleri ve (c) Kuvaterner yaşlı pekişmemiş taraçalar ve alüvyon sedimanları. Gevşek Kuvaterner sedimanlar Ankara'da yoğun olarak yayılmışlardır. Bu sedimanlar ince taneli ve kalınlıkları en fazla 200 m veya daha fazla olan sedimanlardır. Bu sedimanların içinde statik yer altı su seviyesi yüzeye oldukça yakındır (ortalama 6 m). Bu şartlar gevşek alüvyon zeminlerin sıvılaşması için oldukça uygundur. Ayrıca zemin kayası ezik zonlar ile dolu olduğu için Ankara, derin odaklı küçük depremlerle (M≤5) karakterize edilse bile zemin şartlarından dolayı 110 km uzaklıkta Kuzey Anadolu Fay Sistemi ve 80 km uzaklıkta Seyfe Fay Kuşağı kaynaklı büyük depremlerden kaynaklanan riske açıktır.

Anahtar kelimeler: neotektonik, depremsellik, Uruş fay seti, Uruş depremi, Çamlıdere depremi, fay düzlemi çözümü, zemin malzemesi

To my grandfather…

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TABLE OF CONTENT

Page

LIST OF TABLES

TABLE **PAGE**

LIST OF FIGURES

FIGURES …**Page**

Chapter 1

Introduction

1.1. Location of the study area

The study area is the Uruş county and its near vicinity is located 70 km WNW of city of Ankara (Figure 1). Major settlements in the study area are two counties, Uruş and Güdül; and a number of villages such as, from W to E, Macun, Yoğunpelit, Kabaca, Üreğil, Özköy, Tahtacıörencik, Kırkkavak, Kavaközü, Kayı and Karacaören. The study area is 189 km in size and included in 1/25000-scaled topographic quadrangles of H28a_3, a_4, d_1 and d_2.

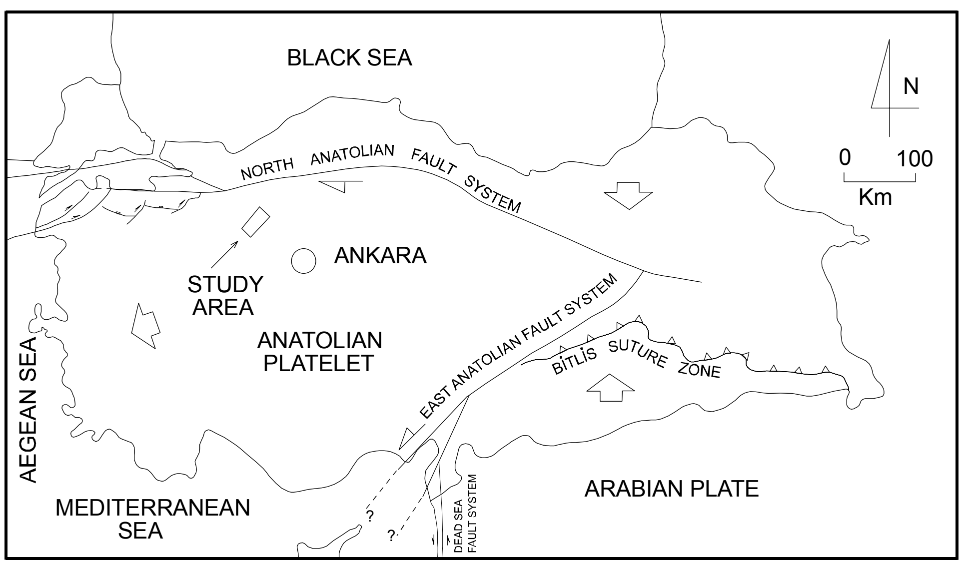

Figure 1. Simplified map showing the study area and major tectonic structures in Turkey and adjacent areas (modified from Koçyiğit 1996).

1.2. Purpose and Scope

In general, the city of Ankara is located in northwest Central Anatolia within the Anatolian platelet. The city of Ankara is approximately 100 km away from the North Anatolian Fault System (NAFS), which is the northern boundary of the Anatolian platelet, and responsible for most of seismicity in Turkey (Figure 1). In the present day the city of Ankara is included in the fourth-order zone of the zone of the Seismic Zonation Map of Turkey (Figure 2) (General Directorate of Disaster Affairs 1996).

This map was prepared based on both the instrumental and field data collected until 1990 year. Most of faults, particularly in Ankara region, were not known until 1970's. However, recent geological works carried out in Ankara region substantiated the existence of a number of isolated fault, fault sets and fault zones of dissimilar size and nature (Koçyiğit 1991, 2003; Gökten et al. 1996; Toprak et al. 1996; Demirci 2000; Adıyaman et al. 2001). In addition, two recent earthquakes, namely the June 6, 2000 Mw=6.0 Orta, and the August 22, 2000 Ml=4.8 Uruş earthquakes occurred and caused severe damages to structures in settlements nearby the city of Ankara (Koçyiğit et al. 2001; Demirtaş et al. 2000). It is also well-known that two earlier large earthquakes, the April 4, 1938 Ms=6.6 Taşpınar (Kırşehir) and the February 1, 1944 Ms= 7.3 Gerede earthquakes have caused several damage and loss of lives eventhough the epicentres of these two seismic events are located 80 km and 100 km, respectively, away from the city center of Ankara (Ambrasseys 2001). Even though it is a small seismic event with a magnitude of Ml=4.8.the 2000 Uruş earthquake caused heavy damage to more than 20 concrete buildings. Similarly, 8 small earthquakes with magnitudes between 2 and 4 occurred between 2003.02.27-2003.03.11 in the Çamlıdere area. This last seismic storm did not cause any damage, but these two seismic events, namely the 2000 Uruş and the 2003 Çamlıdere earthquakes attracted people's attention to the seismicity of Ankara and its close vicinity.

A detailed seismotectonic work in the frame of a MSc. Thesis was planned to find out the source and nature of the 2000 Uruş earthquake, and to asses the cause of heavy damage in the Uruş area.

1.3. Methods of Study

Two groups of data were used to evaluate the seismicity of Uruş region. These are the field data and the instrumental data. The first group of data was obtained by field geological mapping carried out in the Uruş area. The neotetonic rock units and structures (faults, bedding, alluvial fans, landslides, pressure ridges) were mapped on topographic map of 1/25000 scale. Unlike to the field geological mapping, instrumental data, used to perform focal mechanism solutions of both the August 22, 2000 Ml=4.8 Uruş earthquake and the February 27, 2003 Md=4.0 Çamlıdere earthquake, were obtained from Earthquake Research Institute (KOERI) of Boğaziçi University Observatory Laboratory and General Directorate of Disaster Affairs, Earthquake Research Department (ERD). Later on, these two groups of data were evaluated and interpreted. Geological maps, geological cross-sections, and generalized stratigraphical column were preapared by using relevant computer programmes. In addition, focal mechanism solutions of earthquakes were carried out by using first motions of P-waves recorded by KOERI and ERD.

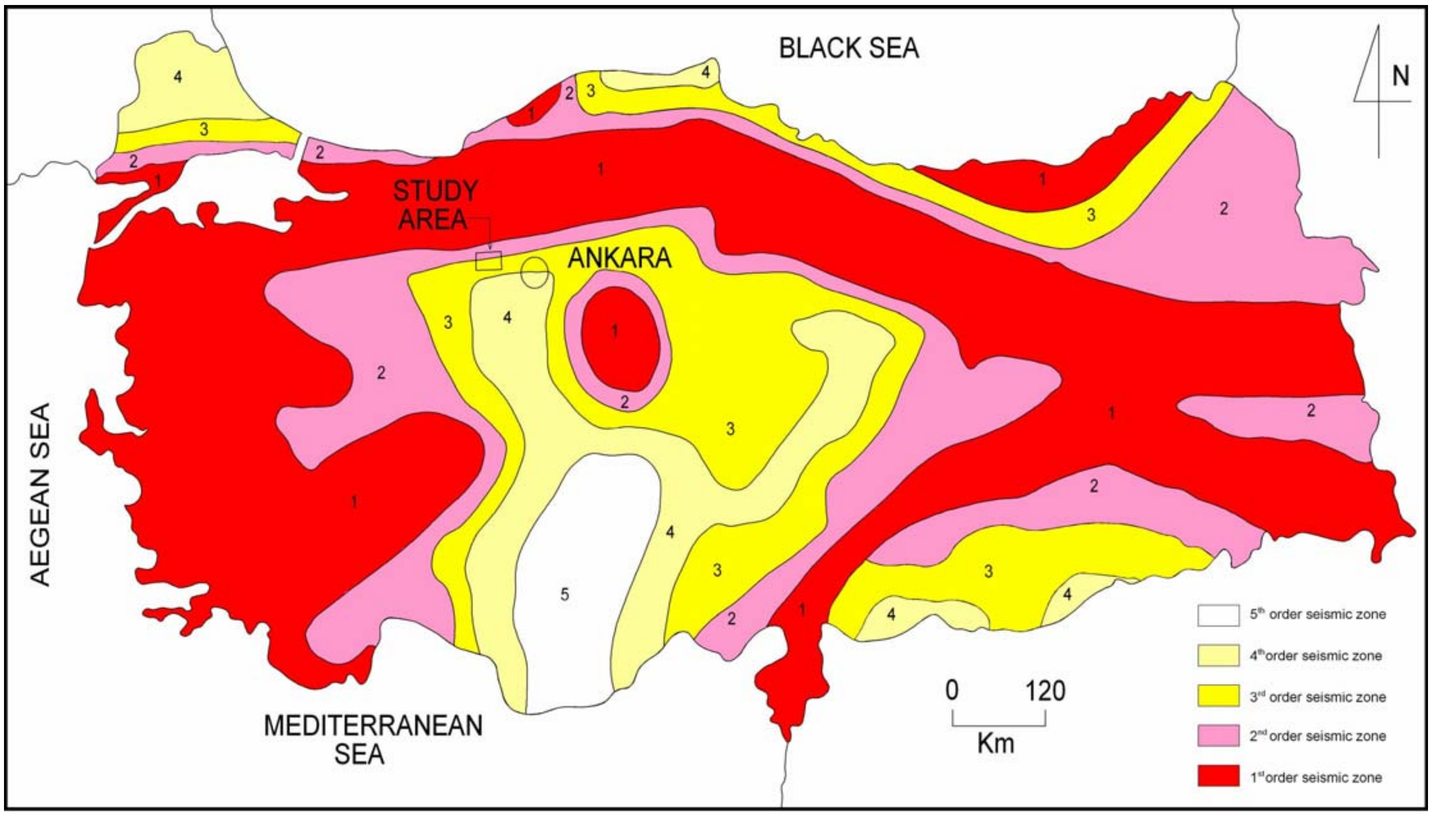

Figure 2. Simplified seismic zonation map of Turkey (General Directorate of Disaster Affairs, 1996)

1.4. Previous Works

A number of geological studies were carried out in the Ankara region. These studies, which go back to the beginning of 1950 years, can be grouped into five categories: (1) General geological to geomorphological studies (Erol 1951, 1954, 1955, 1956, 1961, 1966, 1973, 1993; Akyol 1969; Akyürek et al. 1984; Tokay et al. 1988; Kazancı and Gökten 1998; Türkecan et al. 1991; Saraç 1994), (2) tectono-stratigraphical studies (Bailey and McCallian 1953; Ünalan et al. 1976; Koçyiğit 1987, 1991, 1992; Koçyiğit and Lünel 1987; Koçyiğit et al. 1988; Gökten et al. 1988; Yağmurlu et al. 1988; Gökten et al. 1996; Toprak et al.1996; Rojay and Süzen 1997; Demirci 2000; Adıyaman et al. 2001); (3) Volcanogical to geochemical studies (Öngür 1977; Ach 1982; Tankut et al. 1990; Keller et al. 1992; Wilson et al. 1997; Koçyiğit et al. 2003); (4) Engineering geological studies (Ulusay 1975; Öngür 1976; Kasapoğlu 1980, 2000; Kiper 1983; Koçyiğit and Türkmenoğlu, 1991; Nurlu 1996; Sarıaslan et al. 1998); and (5) neotectonic to seismological studies (Tabban 1976; Koçyiğit 1991b; Ambraseys and Finkel 1995; Baran 1996; Kalafat 1998; Demirtaş et al 2000; Koçyiğit 2003). Some of these studies fall in and nearby the study area (Erol 1955; Öngür 1977; Koçyiğit 1991b, 2003; Gökten et al. 1996; Toprak et al 1996; Baran 1996; Demirci 2000; Demirtaş and et al. 2000; Adıyaman et al. 2001). In order to indicate the significance of the present study a summary of previous works about the study area or its close vicinity will be given below.

Öngür (1977); petrographical geochemical characteristics of volcanic rocks exposing in and adjacent to the northeastern half of the Çeltikçi depression were examined, and faults cutting across these volcanics and fluvio-lacustrine sedimentary sequence were mapped the faults in the study area interpreted as normal faults. He also named the depression, for the first time, the 'Çeltikçi Graben'.

Erol 1955 (1973, 1993); a large part of the Ankara region including the study area was first mapped at a scale of 1/ 100000. In these studies, folded structures of the Tertiary rocks, some faults cutting across the folds and morphotectonic features of the Ankara region were also recognized and mapped by Erol (1951, 1955, 1973, 1993).

Koçyiğit (1991b); this is the first neotectonic work carried out at a regional scale in the Ankara region. In terms of this study, common features of the latest paleotectonic regime such as folds, monoclines and reverse faults, and neotectonic structures, such as the actively growing depressions, their boundary faults cutting and displacing paleotectonic structures were recognized, mapped, classified and named separately. Thus, the first neotectonic map of the region was prepared.

Gökten et al. (1996); this work covers the present study area and deals with stratigraphy and structures of the Kızılcıhamam-Güdül-Ayaş area. In this study, it has been reported that the NE-tending faults are oblique-slip normal faults reflecting a NW-SE- directed extension.

Toprak et al. (1996); this is a regional work about the Galatean Arc Complex. In this study Galatean Complex has been divided into nine volcanic complexes under the title of 'Galatean Volcanic province' shaped by their on calderas, stratovolcanoes and vents. This study suggests that the Galatean volcanics and relevant sedimentary basins are coeval and they have started to develop during the Miocene. Authors also indicated that faults in both the Çeltikçi and Peçenek basins are Pliocene and older structures, have normal fault character. In addition, southern margin-boundary fault of the Peçenek Basin, and the northern margin boundary fault of the Çeltikçi Basin were named the Bayındır Fault and Çeltikçi Fault, respectively.

Baran (1996); this study is the first work dealing with seismicity of northwest Ankara region and was carried out in the frame of MSc. thesis. In this study, focal mechanism solutions of eight earthquakes of magnitude ranging between 3.2 and 4.0 have been performed, but their sources (faults) have not been identified.

Demirci (2000); this study deals with stratigraphy and deformation style of the Tertiary rocks exposing in northwest Ankara. In this frame, previously identified, mapped and named faults and some other structures such as the monoclines have been renamed and streographically analysed.

Demirtaş et al. (2000); this work focuses on both the June 6, 2000 Orta (Çankırı) and the August 22, 2000 Uruş earthquakes. The sources of earthquakes and cause of damages to structures were aimed. However, the source of the Uruş earthquake has been misinterpreted and attributed to a normal fault with dextral strike-slip component.

Adıyaman et al. (2001); this study is, based on both the aerial photograph and satellite image analysis, previously identified, mapped have been renamed once more but mostly misinterpreted. This work, therefore, is misleading readers.

Koçyiğit (2003); this work deals with both neotectonics and seismicity of whole of central Anatolia. It presents the first seismotectonic map of Central Anatolia including actively growing depressions (grabens, strike-slip basins), their boundary faults and relationship between faults and epicenter distribution of both historical and recent (the time period since 1900) earthquakes occurred in the region which also includes the present study area.

CHAPTER 2

STRATIGRAPHY

2.1. Regional Tectonic Setting

From the tectono-stratigraphical point of view, the present study area is located in southern half of the Galatean Arc Complex comprising northwest Central Anatolia. The Galatean Arc Complex is approximately bounded by the major neotectonic structure, the North Anatolian Fault System in the north, and the İzmir-Ankara-Erzincan Suture in the south. The complex is composed of a polyphased volcanic complex and accompanying volcano-sedimentary sequences evolved during subductional, collisional and post-collisional stages of the northern branch of North Neo-Tethys in the period of Late Campanian-Pliocene (Ach 1982; Koçyiğit 1991a; Keller et al. 1992; Koçyiğit et al. 2003) in contrast to the previous studies that refer to a Miocene-Pliocene age works (Öngür 1977; Tankut et al. 1990; Wilson et al. 1977; Gökten et al. 1996; Toprak et al. 1996).

The units exposing in and nearby the study area (Uruş area) are classified into two categories based on tectonic regime and style of deformation. These are the (1) paleotectonic units or basement rocks, and (2) neotectonic units. The paleotectonic units, lies outside of the purpose of this study, therefore, a very brief information about their lithostratigraphical characteristic will be given below. However, neotectonic units will be described in more detail.

2.2. Basement Rocks

The basement rocks cropping out in the Uruş area consists of volcanic rock assemblage and the fluvio-lacustrine sedimentary sequence with the volcanic and gypsum intercalations. Volcanic rocks were previously named as the 'Sorgun Complex' (Toprak et al. 1996), the 'Karaçamtepe Volcanics' and the 'Hacılar Volcanics' (Gökten et al. 1996). Volcanics, from bottom to top, consist of volcanic breccia, agglomerate, blocky lava and lava flows. Angular to sub-rounded from pebbles-to block-sized lava fragments are set in a grey to pinkish-white tuff up to 400 m in thickness. They are overlain by the alternation of andesite to basaltic-andesite lavas, volcanic breccia and tuff. Lavas occur an 0.5-2 m thick layers and display weak flow foliation and porphyritic texture, composed of oligoclase-andesine, hornblende phenocrysts embedded in a glassy matrix (Gökten et al. 1996). Volcanics also occur in form of domes and are cut across by basaltic dykes, in places. Total thickness of volcanics in the study area is about 1 km.

Bottom of volcanics in the study area is not seen, however, they are overlain, with an angular unconformity, by the Middle Miocene fluvio-lacustrine sedimentary sequence, the 'Hüyükköy Formation' at the top (Gökten et al. 1996). Volcanics, therefore, are older than Middle Miocene.

The second type of the basement rocks is a fluvio-lacustrine sedimentary sequence with volcanics and gypsum intercalations. This sequence was previously named as the Hüyükköy Formation (Gökten et al. 1996) and the Uruş Formation (Türkecan et al. 1991). This sedimentary sequence exposes at two localities in the study area. One of these outcrops is the east of Macun village in the west, and the other is the Akçapınar stream valley running from NNW to SSE between Uruş and Güdül counties (Figue 3). The sequence starts with a polygenetic basal conglomerates on the erosional surface of volcanics at bottom, and continues upward with the alternation of sandstone, marl, micritic limestone, gypsum and mudstone. Upper half of the sequence is mostly lacustrine in character and contains channelized conglomerate lenses, thin coal seams and volcanic material-rich

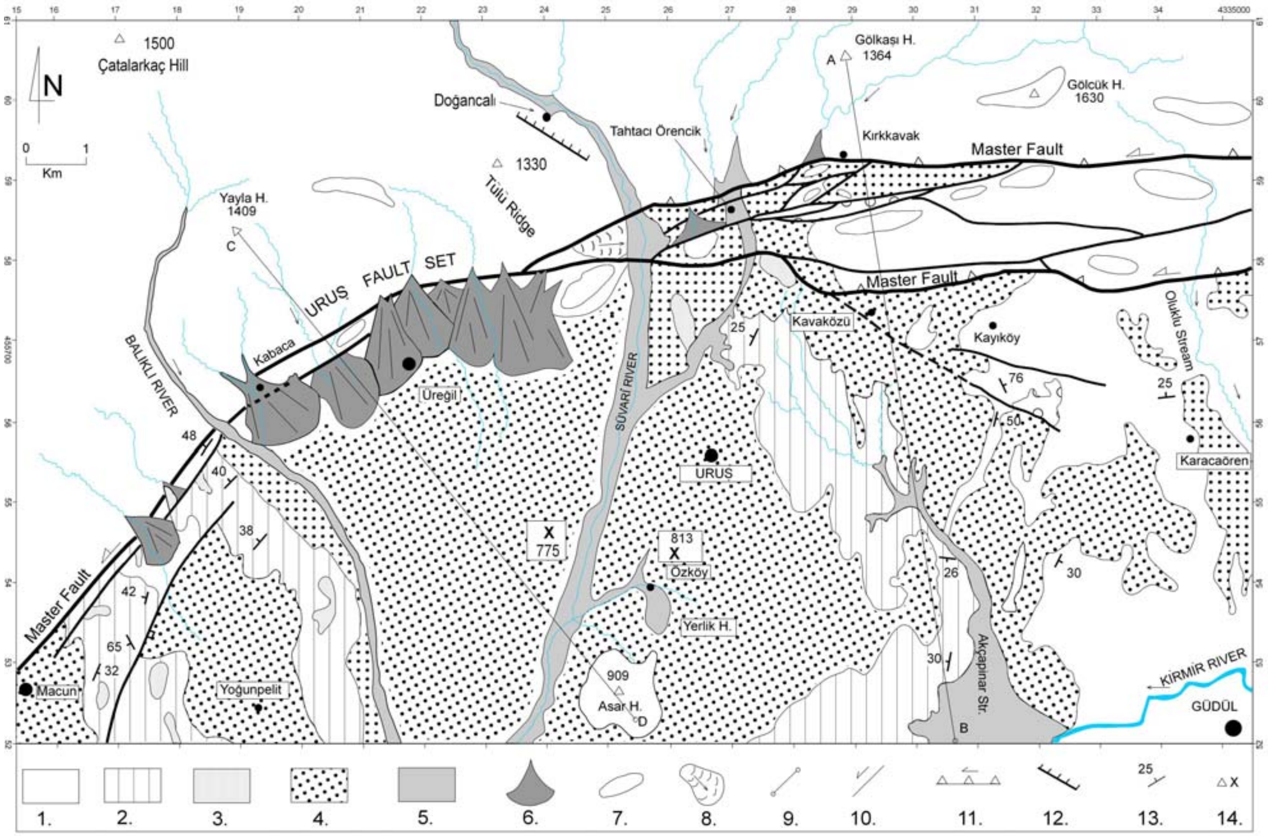

Figure 3. Geological map of the study area. 1. Pre-Pliocene Galatean Arc complex, 2. Fluvio-lacustrine sedimentary sequence of Middle Miocene-Early Pliocene age, 3. Upper Pliocene terrace conglomerate, 4. Plio-Quaternary terrace deposits, 5. Recent alluvial sediments, 6. Alluvial fan 7. Elongated hill (pressure ridge), 8. Landslide, 9. Line of cross-section, 10. Strike-slip Fault, 11. Reverse fault with sinistral strike-slip component, 12. Normal fault, 13. Strike and dip of bedding, 14. Elevations above sea level.

horizons, in places. Conglomerates consist mostly of well-rounded pebble-to boulder-sized clasts of andesite, basalt, chert, limestone and sandstone set in a pinkish-yellow-white sandy matrix. Limestones are mostly siliceous or contain silica nodules. Fluvio-lacustrine sedimentary sequence is full-of syn-depositional structures such as normal faults up to 20 m slip, shear planes, olisthostromes, graded- to cross-bedding and load casts. This sequence is steeply tilted up to 50° and folded into asymmetrical to symmetrical anticlines and synclines (Figure 4).

Figure 4. Field view of asymmetrical syncline in the folded fluvio-lacustrine sedimentary sequence.

Sedimentary sequence has a total thickness of about 300 m. based on polynological and micromammalian fossil data the age of the unit is assigned as Middle Miocene to Early Pliocene (Saraç 1994; Ergun et al. 1996). At the topmost part of the sequence, both volcanics and the fluvio-sedimentary sequence are overlain with an angular unconformity, by the Plio-Quaternary neotectonic units.

2.3. Neotectonic Units

These are the units deposited under the control of neotectonic regime during the Plio-Quaternary period. The neotectonic units are classified into two groups: (1) terrace deposits, and (2) fans to stream bed sediments (Figure 4).

2.3.1. Terrace Deposits

These are the second widespread units in the Uruş area. In general terrace deposits are well-exposed in the downthrown southern block in the Uruş fault set (Figure 3). They occur in diverse-sized outcrops in the area between Karacaören village in the east and Macun village in the west. Terrace deposits also occur in two morphotectonic patterns: (1) fault terraces, and (2) river terraces or plateau. Fault terraces are relatively small, fault-bounded, steep-sided outcrops of conglomerates exposing at higher elevations with respect to river terrace (Figures 3, 5). Fault terrace conglomerates occur in a gently (up to 15°) back-tilted and fault-perched position to be the morphologic reflection of fault activity. Fault terraces overlie with an angular unconformity on erosional surface of the steeply tilted to folded volcanic rocks and the Miocene-Lower Pliocene fluvio-lacustrine sedimentary sequence. Terrace conglomerates consist of well-rounded pebbles, boulders and blocks (up to 1.5 m in diameter) of mostly andesite, dacite, trachyte, basalt, sandstone, radiolarite, chert, quartz set in a volcanic material-rich sandy matrix. Lower section of the terrace succession is relatively well-lithified and strong, but upper sections are weakly lithified altered and loose. They are also cut frequently by shear planes and minor growth faults with secondary mineralization as an evidence of tectonic activity. They have experienced during and after sedimentation (Figure 6). Thickness of the fault terrace conglomerates ranges from a few meters to 50 m of maximum.

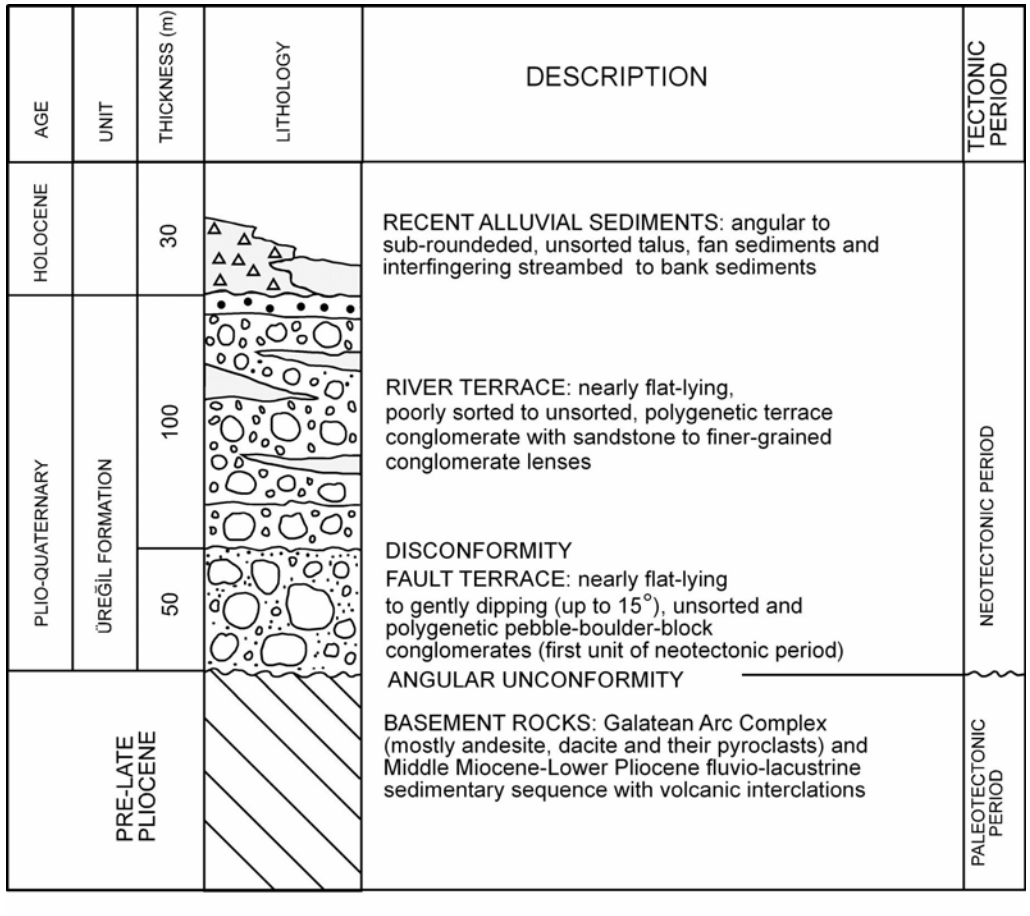

Figure 5. Generalized stratigraphical column of the neotectonic units in the Uruş area.

The river terrace deposits occur as a very broad and nearby flat-lying plateau around the drainage system such as the Kirmir antecedent River and its second-order major branches such as the Balıklı River, the Süvari River, the Akçapınar stream and the Oluklu stream. The river terraces are the elevated (up to 30 m) ancient sediments of this drainage system. They were originally deposited by each of these running waters. They emanate from peaks of mountain range, comprising northern upthrown block of the Uruş fault set and flow down slope in SSE direction, finally deposit all-sized sediments that carry when they reach to mountain front and flood plain. Later on, previously deposited fluvial sediments have been channelized and left at relatively higher elevations to be river terraces as a natural response to vertical down cutting due to tectonic activity or striking change in the climate.

River terrace deposits overly, with an angular unconformity, the highly deformed basement rocks, but display a short-term erosional gap in the older fault terrace conglomerates (Figures 3, 5). River terrace deposits are nearly flat-lying, poorly bedded to unsorted, polygenetic in composition and contain finer-grained conglomerate and sandstone lenses, in places. Towards the top, all gradations are seen between river terrace deposits and recent alluvial and fan sediments. Total thickness of the river terrace deposits is about 100 m.

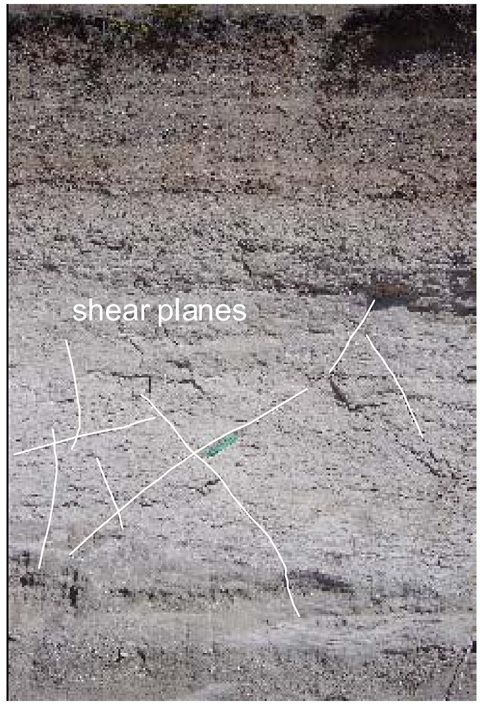

Figure 6. Terrace deposits which were cut by shear planes (pencil in the photo for scale ~14 cm).

Fault terrace conglomerate is the first unit of neotectonic period. No age data could be obtained in the study area. However, similar terrace deposits are also well-exposed in the Üçbaş-Akdoğan graben located 60 km NNW of Ankara. Terrace deposits in the Üçbaş-Akdoğan graben were studied in detail and dated to be earliest Pleistocene based on macro-and micromammalian fossil content by Erol (1993). Thus, the age of fault terrace conglomerates and overlying river terrace deposits altogether is accepted Plio-Quaternary when compared with Üçbaş-Akdoğan outcrop and named as the Üreğil formation (Figure 5).

2.3.2. Recent Sediments

These are the combination of recent stream bed deposits, alluvial fans and talus sediments accumulated along fault scarps to the mountain front. The stream bed sediments are mostly the midchannel-and point-bar deposits filling the large rivers, such as the Balıklı, Süvari and Akçapınar rivers. They consist of sand-silt, pebble, boulder-block accumulation and show well-developed clast imbrication, gradded-bedding and cross-bedding. They are well-exposed when these three rivers or transporting agents dry up during summer time. The second category of recent sediments are the alluvial fans and talus deposits accumulated at or nearby the mouths of second-and/or third order streams emanating from peaks of hills and ridges in the northern upthrown block of the Uruş fault set and flowing down-slope direction into southern down-thrown block. Alluvial fans range in size from a few hundreds square meters to 1 km^2 and align parallel to faults. They consist of unsorted, angular pebble, boulder-blocks set in sandy-silty matrix. Maximum total thickness of recent sediments is about 30 m.

CHAPTER 3

STRUCTURAL GEOLOGY

3.1. Çeltikçi Fault Zone

The 2-8-km-wide, ~65-km-long and N60°E-trending morphotectonic depression located between Kızılcahamam in the northeast and Beypazarı in the southwest was first named the Çeltikçi Fault Zone (Koçyiğit 2003). The faults bounding its northeastern half were previously mapped and interpreted as normal faults, and then same area was named as the 'Çeltikçi Graben' by Öngür (1977). Later on, the northern margin-boundary fault of the same area was examined and interpreted to be an oblique-slip normal fault with minor sinistral strike-slip component, and it was named as the 'Çeltikçi Fault' by Toprak et al. (1996). Gökten et al. (1996) have also mapped a broad part, including the present study area, of the Çeltikçi Fault Zone, and interpreted the NE-trending faults as oblique-slip normal faults with minor amount of dextral strike-slip component. They have also suggested that the extension during neotectonic period is operating in N25°W direction. Based on satellite image analysis, Adıyaman et al. (2001) have also identified the existence of the northern margin-bounding fault of the Çeltikçi depression, and they interpreted it to be normal fault. Finally, Demirtaş et al. (2000) have named the fault segments exposing in the north of Uruş as the 'Uruş-Güdül Fault', and they interpreted these fault segments as normal faults with dextral strike-slip components. The southwestern extension of the so-called 'Orta-Devrez Fault' is also interpreted as a normal fault without doing any field-geological mapping, aerial photograph study or satellite image analysis.

The Güdül-Uruş section of the Çeltikçi morphotectonic depression drained by the antecedent river and its second-order drainage system was first mapped in detail in the present study, and faults determining the northern margin of the Çeltikçi depression were named as the Uruş fault set within the Çeltikçi Fault Zone (Figures 3 and 7).

3.2. Çeltikçi Fault Set

In general, the 65 km long and NE trending shear zone determining the northern boundary of the Çeltikçi depression is here termed the Çeltikçi fault set. The Macun-Karaağaç section of this fault set was examined and mapped in detail in this study. In the study area, the Uruş fault set consists of 3-15 km long, closely-spaced (75 m-1 km), parallel to sub-parallel several fault segments. The master fault of the fault set separates volcanics from the Plio-Quaternary basin fill and the underlying fluvio-lacustrine sedimentary sequence. The master fault enters the study area nearby Macun Köy in the west, and then runs in N47°E direction up to Kabaca village, where it jumps towards left by about 0.3 km (Figure 3). Around Kabaca village and Çamkoru stream, the master fault bends 18° and 15° towards right, respectively, and then it trends in N80°E direction. In the south of Tülü Ridge, the master fault first bifurcates into two sub-strands (Figure 7). Later on, the southern sub-strand bifurcates again into two or more third-and fourth-order subbranches, and then they rejoin to rebifurcate. The subbranches divide the crust, made-up of volcanics, into a series of lensoidal blocks in the shape of elongated hill (pressure ridge) and intervening deep and narrow troughs filled by loose sediments (Figure 8). These elongated hills and troughs with long axes parallel to the general trend of the boundary faults are very diagnostic features for the strike-slip faulting-induced tectono-morphology (Figure 3). Finally, the master fault and its sub-strands run outside the study area nearby the Karaağaç settlement. A series of morphotectonic features occur in and adjacent to the Uruş fault set. Some of them are the fault-parallel-aligned alluvial fans with apices adjacent to the master fault, deflected streams, lazy S-shaped bended drainage systems such as the Balıklı River, the Süvari River and the Akçaöz stream (Figure 9), active land-slides, back tilting of the fault-bounded blocks, and fault-perched terrace conglomerates. In addition, the Uruş fault set, particularly its master fault, displays a south-facing and steep fault scarp with a relief of 700-800 m. Consequently, the whole of these morphotectonic structures are the morphologic expression of a fault activity, i.e., the master fault of the Uruş fault set is an active fault and display characters variable from left lateral strike-slip fault along its N47°E-trending Macun-Kabaca segment to again a strike-slip fault with a considerable amount of reverse component along its nearly E-W-trending part. Activity and nature of the Uruş fault set was also proved by the August 22, 2000 Ml=4.8 Uruş earthquake and its focal mechanism solution, which was first carried out in this study, and will be presented in next chapter. In the same way, the activity of the Çeltikçi section Uruş fault set was also confirmed by a series of small earthquakes occurred in a short time slice between 1900-2003 and 2000-2004 (KOERI 2003; ERD 2003).

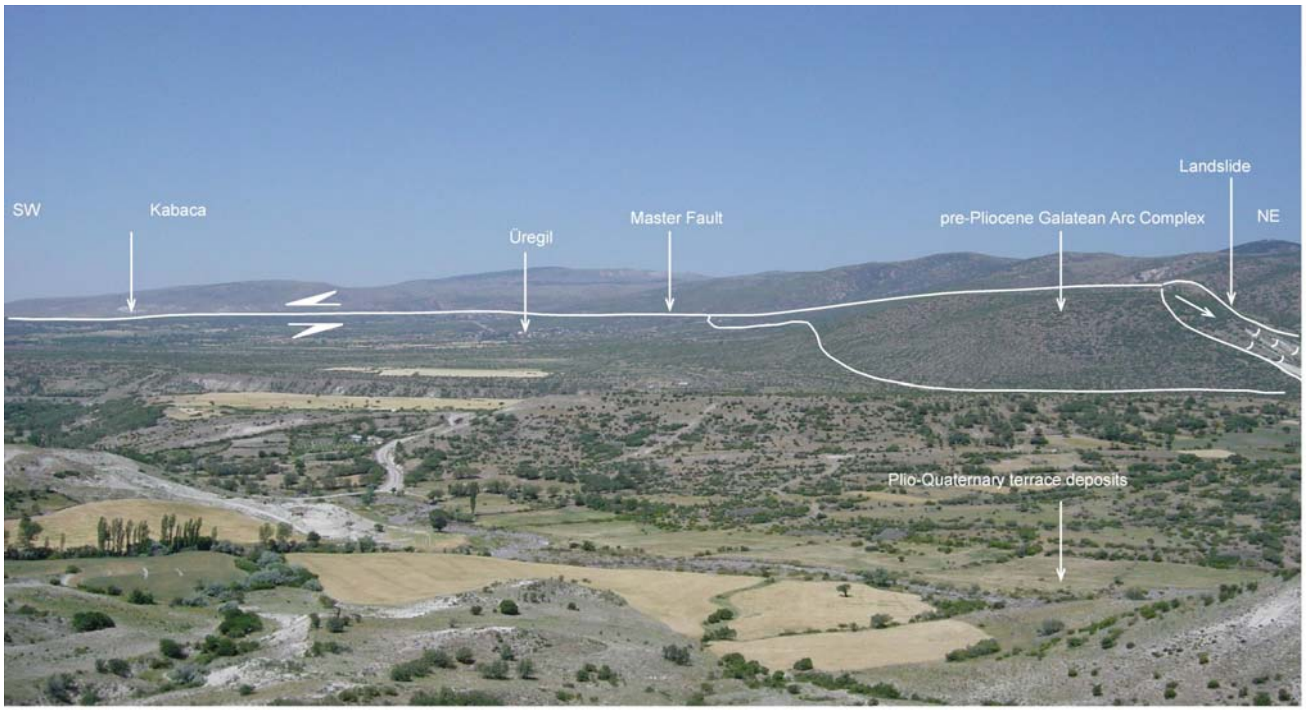

Figure 7. General view of the Uruş Fault Set

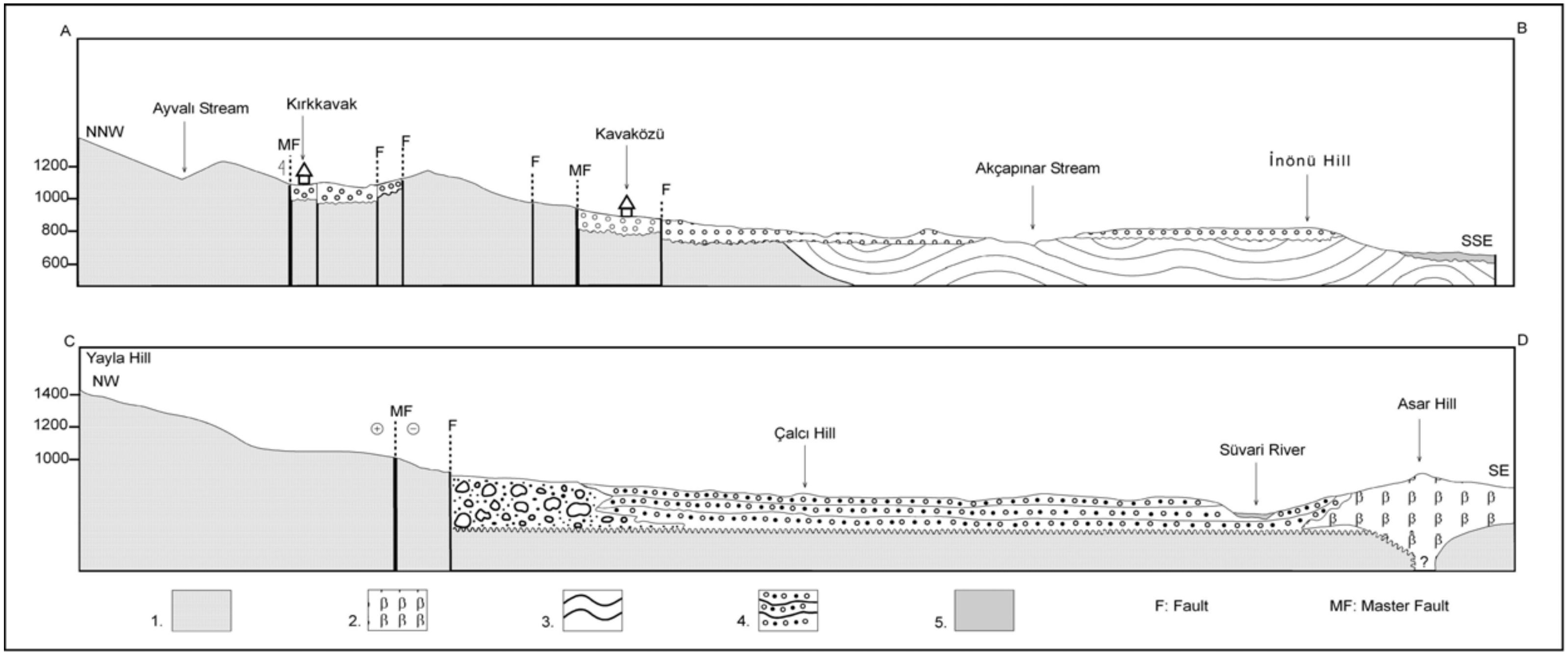

Figure 8. Geological cross-sections of the study area. 1. Pre-Pliocene Galatean Arc Complex (Mostly andesite). 2. Pre-Pliocene Galatean Arc Complex (Mostly basalt). 3.Fluvio-lacustrine sedimentary squence of Middle Miocene-Early Pliocene age. 4. Plio-Quaternary Terraceconglomerate. 5. Recent alluvial sediments.

Figure 9. S-shaped stream bed from east part of the Uruş Fault Set.

CHAPTER 4

SEISMICAL OUTLINE OF ANKARA REGION

In general, the city center of Ankara is located along the boundary of the third- and fourth-order subzones of the seismic zonation map of Turkey (Figure 2). However, various districts and some counties of Ankara, such as Gölbaşı, Etimesgut, Sincan, Ayaş, Haymana and Polatlı are included in the fourth-order subzone of the seismic zonation map.

The earthquakes occurred in any time before 1900 years are here termed to be the historical seismic events, while those occurred after 1900 are named as the recent earthquakes.

4.1. Historical Earthquakes

In the earthquakes catalogues, only one historical earthquake has been reported. This is the 1875 Mamak (Ankara) earthquake with the intensity of VI (Ergin et al. 1967). But this seismic event has not been well-defined, because there is no information about its damage and casualties. However, several historical earthquakes originated from the North Anatolian Fault System in the north have caused severe damage to structures and loss of lives in Ankara and its counties such as Beypazarı, Ayaş and Çubuk (Figure 10). The well-known of these historical earthquakes are the 1968 seismic events. In the earthquakes catalogues, it has been reported that the city of Ankara had been affected by a series of historical earthquakes of intensities VII-IX occurred in the short time slice between July 3, 1968 and August 18, 1968. These are the July 3-10, 1968 Bolu-Kastamonu

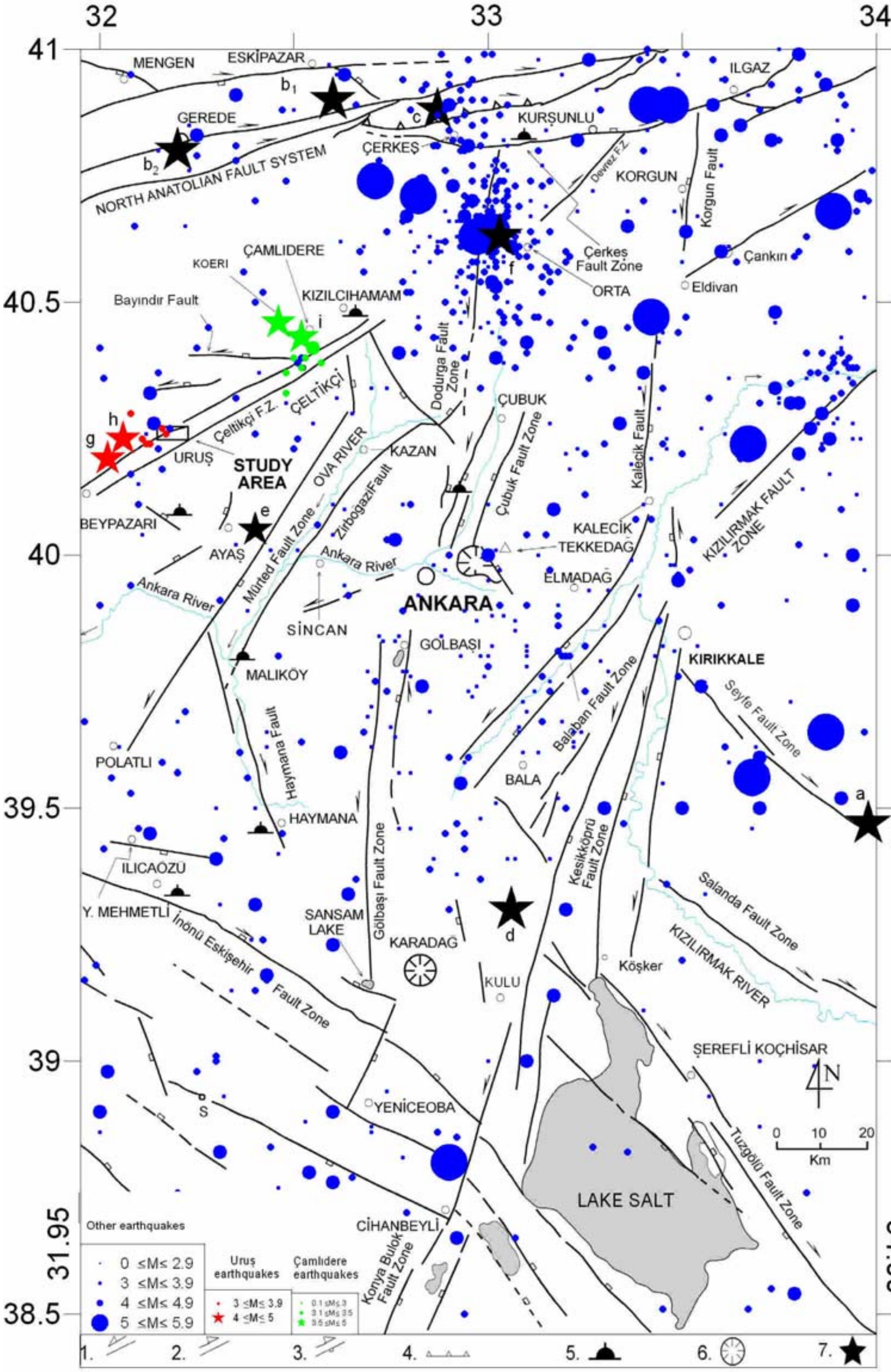

Figure 10. Simplified seismotectonic map of the Ankara region and its vicinity (Modified from Koçyiğit 2003). 1. sinistral strike-slip fault, 2. dextral strike-slip fault, 3. strike-slip fault with normal component, and oblique-slip normal fault with considerable strike-slip component, 4. thrust fault, 5. thermal spring, 6. volcanic center, and 7. epicenter of destructive earthquakes described in text (Seismic data was provided by KOERI and ERD).

earthquakes (Soysal et al. 1981), the August 12-15 1968 Ankara earthquakes (Ambraseys and Finkel, 1995), the August 17, 1968 Amasya-Tokat earthquake (Soysal et al. 1981), and the 1968 Bolu-Kastamonu-Amasya earthquakes (Ergin et al. 1967). Indeed, all these earthquakes may represent separate seismic events, or only one of them, namely the August 17, 1968 earthquake may be the main shock, remains are aftershocks originated from the nearby fault segments reactivated due to the triggering effect of the main destructive earthquake, the second possibility (the August 17, 1668 Amasya-Tokat historical earthquake) is much more possible, because a ground rupture of 380 km long has developed during this earthquake. This ground rupture may correspond to a destructive earthquake with magnitude at least 8.0 when compared with the 1939 Erzincan earthquake of Mw=7.9, during which 360-km-long surface rupture has developed (Soysal et al. 1981). The approximate epicenter of the August 17, 1668 Amasya-Tokat earthquake is about 285 km away from the city of Ankara, and it is located in a somewhere nearby the Ladik county. This historical earthquake may have affected Ankara. However, Ambraseys and Finkel (1995) has reported that the August 12, 1668 and the August 15, 1668 historical earthquakes had caused severe damages to structures in the historical Ankara Castle and houses in Beypazarı, and led to loss of nine people . Consequently, big destructive earthquakes may cause severe damage to structures in Ankara eventhough the epicenter of the earthquake is located away 285 km from it. Owing the external factors such as liquefaction, ground amplification and other ground material conditions.

4.2. Recent Earthquakes

In general, the Ankara region is accepted quiet seismically. Indeed, this is not true, because in the period of 1900-2004, about 826 earthquakes occurred in the Ankara region and its near vicinity is 863 (Table 1) (KOERI 2003; ERI 2004). Two of these earthquakes have a magnitude of ≥6.0, while twelve of them have magnitudes ≥5 but <6.0. The magnitudes of remaining

425 seismic events are greater than 3 but smaller than 5. The number of earthquakes with magnitudes ≤3 is 387. Consequently, the Ankara region is dominated by small earthquakes. The number of earthquakes, which affected the city center of Ankara and the nearby smaller settlements included in the Ankara region, is 19. six of these earthquakes, magnitudes of which range between Md=4.0 and Mw=7.4, occurred directly inside the city of Ankara, and remaining 13 earthquakes took place outside of the Ankara region. Some of these earthquakes will be described separately and in a little greater detail below (Table 2).

4.2.1. 1938.04.19 Akpınar-Taşkovan (Kırşehir) Earthquake

The intensity and magnitude of this destructive earthquake is IX and Ms=6.6, respectively. This seismic event was felt strongly in Kırşehir, Yozgat, Konya, Sivas, Kastamonu, Eskişehir and Amasya. It caused severe damage and loss of 158 people in the Taşkovan and Akpınar towns, because its epicenter is located in an area (39.47°N-39.98°E) between the two settlements. Effect of the 1938 Akpınar-Taşkovan earthquake to Ankara was about intensity VI. It formation of cracks on the walls and falling of chimneys of a number of single-story and apartment houses in especially Yenişehir, Ulus and Kızılay districts of Ankara, although the epicenter of the earthquake is located ~80 km away from the city center of Ankara (Figures 10 and 11).

The 1938.04.19 Akpınar-Taşkovan earthquake has been sourced from reactivation of the Akpınar section of the Seyfe right lateral strike-slip fault zone (Koçyiğit 2003). This is also confirmed by the focal mechanism solution of earthquake (Jackson and McKenzie 1984) (Figure 11).

4.2.2. 1943.11.26 Ladik-Ilgaz and 1944.02.01 Çerkeş-Gerede Earthquakes

These two big earthquakes have been originated from the reactivation of Abant-Ladik section of the North Anatolian Fault System (NAFS). Intensities and magnitudes of these two devastative earthquakes are X, Ms=7.3 and Ms=7.4, respectively. The epicentral locations of both earthquakes are Ilgaz (41.00N-33.60E) and Bayındır (Eskipazar-Çerkeş) (41.00°N-33.50°E), respectively (Dewey 1976; Ambraseys 2001). Especially the 1944 Çerkeş-Gerede earthquake has been felt strongly in a very broad area, covering İzmit, Ankara, Amasya, Sinop and Zonguldak cities, and led to 7471 causalities and collapse of 20865 structures. Eventhough the epicenter of the 1944 Çerkeş-Gerede earthquake is ~110 km away from the city center of Ankara (Figure 11), it caused loss of 125 lives, 158 injuries and collapse of 1450 structures in Kızılcahamam, Çamlıdere and Ayaş counties of Ankara. As in the case of 1938 Akpınar-Taşkovan earthquake, the damage caused by the 1943 and 1944 earthquakes has been concentrated in Yenişehir and Ankara castle districts of Ankara.

Both the 1943 Ladik-Ilgaz and the 1944 Çerkeş-Gerede earthquakes have origins same as the 1668.08.12-15 Bolu-Kastamonu-Amasya earthquakes (Ergin et al. 1967), and their reoccurence are 275 and 276 years, respectively. The length of time slice elapsed since the 1944 Çerkeş-Gerede devastative earthquake is 60 years. In 1944, the population and construction densities in Ankara were very limited compared to those in today. It is not so difficult to estimate amount of future (~200 years later) earthquake risk in Ankara, because its population and construction densities will be several times of todays.

4.2.3. 1983.04.21. Sofular-Köşker (Kulu) Earthquake

This is the Ms=4.8 small earthquake with a focus of 10 km depth (Eyidoğan et al. 1991). Epicenter of this earthquake is the near west of Sofular village (Kulu), ~70 km SE of Ankara (Figure 11). The 1983 earthquake caused collapse of 2 houses in Sofular and 60 houses in Köşker village. This earthquake has been felt in the intensity of V. the focal mechanism solution of the 1983 Sofular-Köşger earthquake indicated that its source is a NE-striking left-lateral strike-slip fault with a considerable amount of normal component (Kalafat 1998).

Table 2. Various seismic parameters of earthquakes affecting Ankara region.

Date	Origin Time (GMT)	Location Lat.N-Long.E	Focal Depth Km	Magnitude	Fault Plane sol. strike/dip/rake	Geographical Region Site	Reference
1938-04-19	10:59:20	39.47-33.98	10	Ms=6.6	1.118°/ 87°/ ?	Kırşehir	Jackson and McKenzie,
					2.30°/ 60°/ ?		1984
1944-02-01	03:22:40	40.80-32.20	12	Ms=7.4	1.0.62°/ 77°/ ?	Çerkeş	Canıtez&Büyükaşıkoğlu,
					2.322°/ 60/ ?		1984
1951-08-13	18:33:34	40.88-32.87	10	Ms=6.9	1. 352°/ 85°/ ?	Çerkeş	TERI in: Koçyiğit, et.al.,2001
					2.262°/ 90°/?		
1983-04-21	16:18:57	39.31-33.06	36	Mb=4.7	-	Kula (Bala)	Kalafat,1998
1995-04-04	11:23:28	40.40-32.77	7	Md=4	-	Başbereket (Ayaş)	Baran (1996)
2000-06-06	02:41:51	40.63-33.03	10	Ms=6.1	1.02°/46°/-29°	Orta (Çankırı)	TERI in: Koçyiğit, et.al.,2001
					2.11°/70°/-132°		
2000-08-22	11:40:12.32	40.23-32.06	0.04	Md=4.3	1.226°,/58°/ 4°	Uruş (Ankara)	KOERI and this study
					2.133°/ 86°/ 148°		
2000-08-22	11:42:05.21	40.19-32.02	7.6	Md=3.8	1.120°/66°/112°	Uruş (Ankara)	KOERI and this study
					2.256°/ 33°/ 50°		
2003-02-27	18:36:58	40.43-32.52	2.1	Md=4.0	1.108°/ 55°/ -111°	Çamlıdere (Ankara)	KOERI and this study
					2.322°/40°/ -62°		

* References were given based on fault plane solutions of earthquakes.

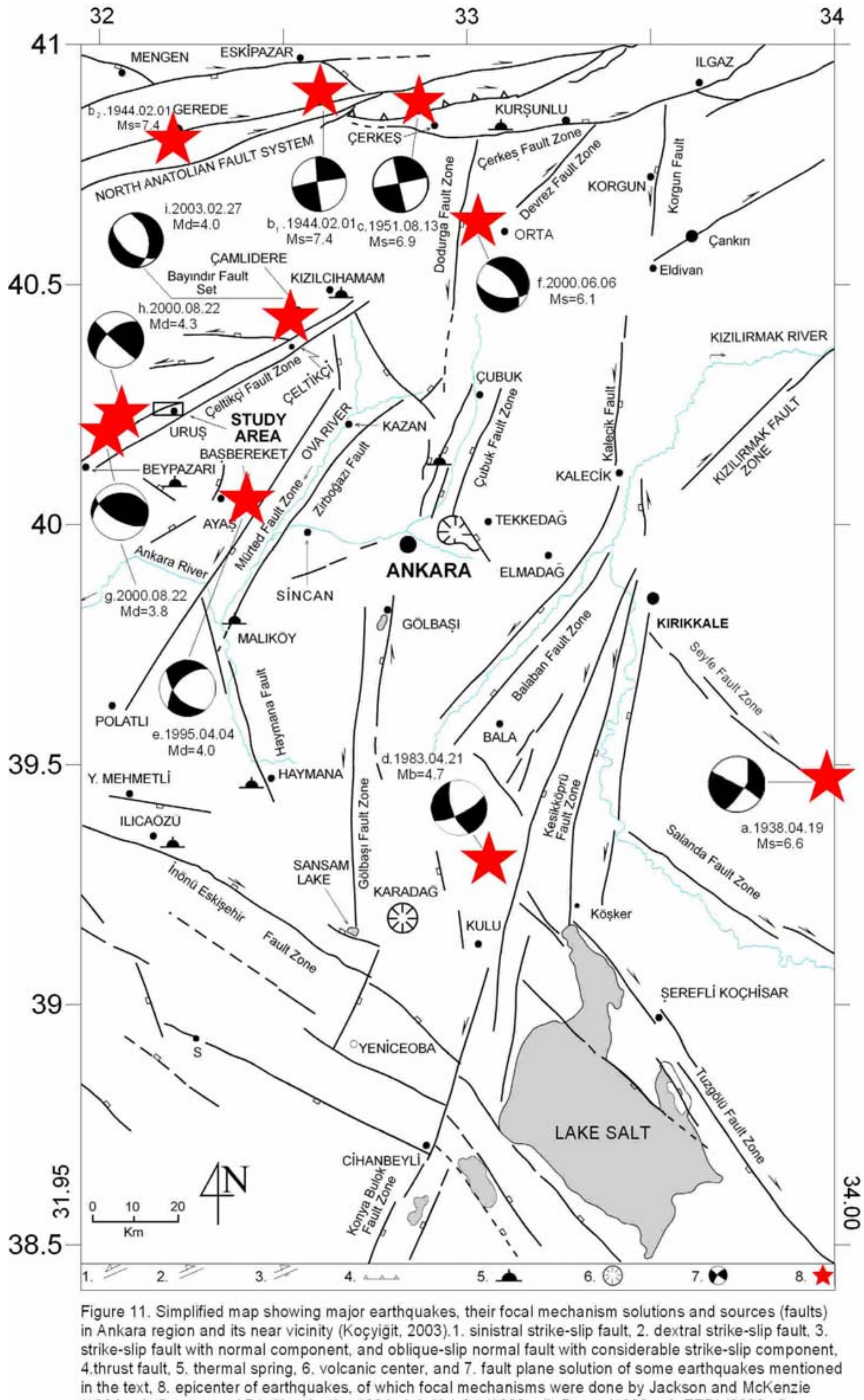

Figure 11. Simplified map showing major earthquakes, their focal mechanism solutions and sources (faults) in Ankara region and its near vicinity (Koçyiğit, 2003).1. sinistral strike-slip fault, 2. dextral strike-slip fault, 3. strike-slip fault with normal component, and oblique-slip normal fault with considerable strike-slip component, 4.thrust fault, 5. thermal spring, 6. volcanic center, and 7. fault plane solution of some earthquakes mentioned in the text, 8. epicenter of earthquakes, of which focal mechanisms were done by Jackson and McKenzie (1984 : a), Canıtez and Büyükaşıkoğlu (1984 : b_1), Kalafat (1998 : d), Baran (1996 : e), TERI (2000 : f) and this study (2004 : g, h, i), Gencoğlu et al. (1991 : b_2), Canıtez and Üçer (1967 : c).

4.2.4. 1995.04.04 Başbereket (Ayaş) Earthquake

This is the Md=4.0 and shallow-focus (11 km) earthquake, epicenter of which is located in the Başbereket village ~60 km WNW of Ankara (Figure 11). This seismic event was felt in Ankara, but it has not caused any damage to structures. Focal mechanism solution of this small earthquake (Baran 1996) indicated that it has originated from a NE-striking oblique-slip normal fault with a considerable amount of right lateral strike-slip component (Figure 11).

4.2.5. 2000.06.06 Orta (Çankırı) Earthquake

This is the Mw=6.0 and shallow –focus (10.5 km) earthquake located 8 km west of the Orta County and 80 km away from city of Ankara (Demirtaş et al. 2000; Koçyiğit et al. 2001). This earthquake was felt strongly in Ankara, Zonguldak, Kastamonu and Çankırı, and caused severe damage to both single-story masonry houses and multi-story concrete buildings in Orta county and its villages. During earthquake 2 people lost their lives and 4822 structures were damaged at different degrees. The 2000 Orta earthquake was felt in the intensity of VI, and it cased a moderate damage to structures in the Çubuk county of Ankara.

Both the field geological mapping (Koçyiğit et al. 2001) and focal mechanism solution of the 2000 Orta earthquake indicated that it has been sourced from reactivation of the master strand of the Dodurga Fault Zone, which is one of antithetic secondary structures of the NAFS (Koçyiğit et al. 2001).

Remaining two recent earthquakes, namely the 2000.08.22 Uruş earthquake and the 2002.02.27 Çamlıdere earthquake, and their focal mechanism solutions are one of major scopes of this study; therefore these two seismic events will be explained under separate headlines below.

4.2.6. 2000.08.22 Uruş (Ankara) Earthquake

A small magnitude (Md=4.3 or Ml=4.8) and shallow-focus (10 km) earthquake struck on August 22, 2000 at 11:40:12.32 (GMT) (KOERI 2000; ERD 2000). The instrumental epicenteral coordinates of this event were declared to be 40.23°N, 32.06°E by KOERI (2000), and 40.19°N-32.02°E ERD (2000). However, observable epicenter of this small earthquake is located, based on intensity or degree of damage observed on ground surface, in an area among Kırkkavak, Tahtacıörencik and Kavaközü villages (Figure 3, 10). The main shock was followed by a series of aftershocks with magnitudes less than 4.0. The main shocks and six aftershocks are listed on (Table 3).

The 2000.08.22 Uruş earthquake was felt over a wide region including cities, counties and villages such as Ankara, Eskişehir, Bolu, Gerede, Beypazarı, Ayaş, Kazan, Polatlı and Çubuk. It caused some serious damages in Uruş, Güdül and villages such as Kırkkavak, Tahtacıörencik, Kavaközü, Kayıköy and Özköy (Figure 3). The earthquake caused severe damage to 12 concrete buildings at the city center of Uruş, 3 km south of the master fault of the Uruş fault set (Demirtaş et al. 2000). This damage contrasts with the magnitude of the seismic event of Ml=4.8. The contrast between the intensity and magnitude of the 2000.08.22 Uruş earthquake may be attributed to both the construction technique of structures and geologic parameters such as type of ground material and geologic structures (active fault) beneath them. The construction technique and materials used in this area are outside of the scope of this study. However, physical behaviour of ground material (elasticity, grain size, water content, liquefaction capacity, etc.) and type of the geologic structure (active fault) are main scope of this study, and they will be explained in the foregoing chapters.

No ground ruptures have developed, but some mass-wasting processes, such as rock fall, slump and landslides occurred and clocked communication to settlements for a short time.

4.2.6.1. Fault Plane Solution of 2000.08.22 Uruş (Ankara) Earthquake

In general, fault plane solution is carried out by using four methods: P waves, S waves, Surface waves and Inversion applying methods**.**

Fault Plane Solution which is done by using S waves is based on benefiting from amplitudes and first motions of SH and SV components together with polarization angles of S waves. The motion of S waves is always examined by separating SH and SV components (Figure 12). SH are waves which are polarized as doing transversally vibrations along the ray orbits of S waves. SV waves are the waves which are polarized in vertical plane which passes from ray way. Both SH and SV waves are co-planar in the same plane which is called polarization plane of S waves. The polarization of wave is determined by polarization angles.

Determining the first motions and commencement of S waves can be difficult. But, the use of polarization angle would ease the job of fault plane solution. Polarization angle belong to each station is projected on focus sphere by using Wullf or Schmidt projection methods. The advantage of this method in compared to P waves applying method is the use of only one nodular plane.

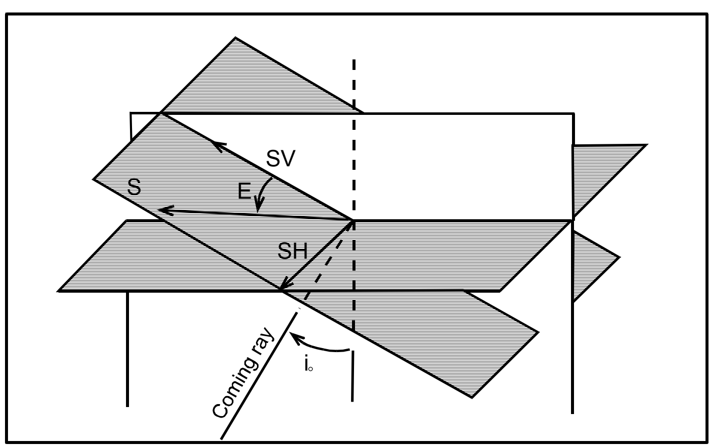

Figure 12. SH and SV components and polarization angles of S waves (Kalafat 2000).

Table 3. Various seismic parameters of 2000.08.22 Uruş (Ankara) earthquake and its some aftershocks (KOERI 2000, ERD 2000)

Date	Origin Time (GMT)	Location Lat°. N-Long°. E	Focal Depth Km	Magnitude	Fault Plane sol. strike/dip/rake	Geographical Region Site	Reference
2000-08-22	11:40:12.32	40.23-32.06	10	*Md=4.3	1. 226°/ 58°/ 4°	Uruş (Ankara)	KOERI and this study
					2. 133°/ 86°/ 148°		
2000-08-22	14:42:05.21	40.19-32.02	7.6	Md=3.8	1. 120°/66°/112°	Uruş (Ankara)	KOERI and this study
					2. 256°/ 33°/ 50°		
2000-08-22	14:42:14.38	40.25-32.13	10	**Ml=4.8	-	Uruş (Ankara)	ERD
2000-08-22	11:48:80.0	40.22-32.12	1.7	Ml=3.1	-	Uruş (Ankara)	ERD
2000-08-22	14:42:14.0	40.23-32.11	5.3	Ml=3.7	-	Uruş (Ankara)	ERD
2000-08-22	16:54:42.0	40.28-32.08	10.2	Ml=3.8	-	Uruş (Ankara)	ERD
2000-08-22	15:57:86.0	40.24-32.17	3.5	Ml=3.1	-	Uruş (Ankara)	ERD
2000-08-24	15:05:36.0	40.22-32.13	10	Ml=3.6	-	Uruş (Ankara)	ERD
2000-08-25	10:44:14.0	40.25-32.16	10.2	Ml=3.5	-	Uruş (Ankara)	ERD

Using of Surface waves for fault plane solution has been increased since the development of seismograph network. Especially, it is easy to face well developed Surface waves in long period seismograms of shallow focused earthquakes. Amplitude distribution of Love and Rayleigh waves may change depending on focal depth and the characteristics of medium where surface waves passed. To sum up, fault plane solution can be done by benefiting from the properties of radiation ways of Surface waves.

One of the basic problems of Geophysics is to model the source by using observed data. During Inversion process, observed and theoretical data are used to apply this method. The aim is to fit these two data sets as much as possible. When well fit is reached, the parameters of theoretical data are accepted as parameters of observed data. In seismology the tectonic properties of the region and kinematic properties that control this region are known. This causes the development of synthetic seismograms. In conclusion, amplitudes and waveforms of P and SH waves of some stations are modelled and fault plane solutions of them are performed. At the end of this process, source parameters and rupture process of earthquakes can be examined.

In this study, P waves applying method was followed for fault plane solutions of Uruş and Çamlıdere earthquakes. For this method three data set are required: (1) station data of first motions of P waves, (2) Take-off angles of seismic waves, and (3) azimuths of stations. The center of the projection sphere is accepted as the center of the earthquake. The projection of seismograph on focus sphere was carried out at two stages: First, azimuth values of each station according to epicenter are determined, then take-off angles of seismic waves are plotted. The first motion of P wave (compression, dilatation) is plotted at this stage. This presents first motion of station and locates the position of the station on focus sphere. This process is repeated for each station. At the end, compression and dilatation regions are separated by the help of one meridian of the projection sphere. This plane obtained is one of the nodular planes. The second nodular plane is perpendicular to this nodular plane, which is chosen for separating the projection sphere into four regions.

Fault plane solutions were carried out for three earthquakes in this study. The data is gathered from Boğaziçi University Kandilli Observatory and Earthquake Research Institute Seismology Laboratory (KOERI).

Events are recorded at the center both in analog and digital forms using telemetred, broad-band and online seismic stations. They are processed by using ‘HYPO71’ for the hypocenter determination. The data which is recorded as analog type is transferred to the computers and converted into digital data by the help of converters. (Figures 13, 14, 15) Observatory and Earthquake Research Institute Seismology Laboratory provides mainly 3 kinds of seismological data to the earth scientists; these are phase readings, waveform and catalogue.

Boğaziçi University Kandilli Observatory and Earthquake Research Institute Seismology Laboratory (KOERI), has a network of 69 stations: 7 are ‘broad band station’, 35 are ‘online station’, 12 are ‘telemetri’, 6 are ‘telemetri nmx’, 3 are ‘stable station’. The information about stations is given in Table 4

In order to do fault plane solutions of Uruş and Çamlıdere earthquakes, two computer programmes were used, namely AZMTAK and PINV and .exe prolongated. They run in DOS environment. A basic information about how these programmes will be explained step by step.

In order to do fault plane solution a file, which involves station names, polarities of wavelengths, coordinates of earthquakes, depth of focus and the number of stations which, recorded the earthquake, is constituted. The prolongation of file must be ‘dat’ (Figure 16).

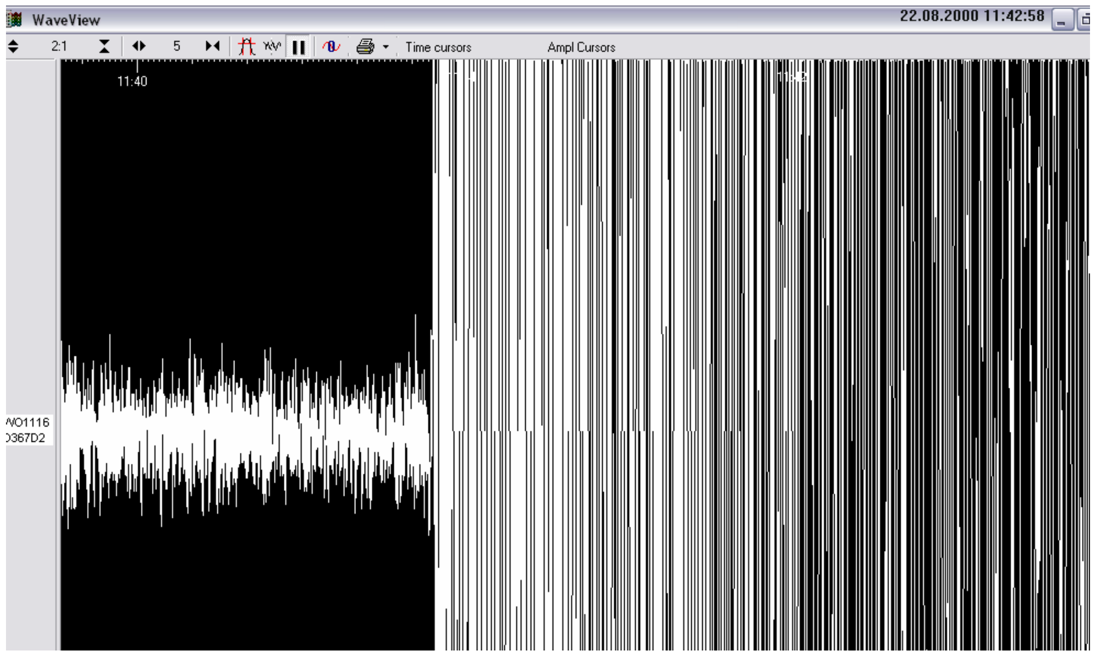

Figure 13. A wave view of 2000.08.22 Uruş earthquake obtained from Boyabat (BYT) station.

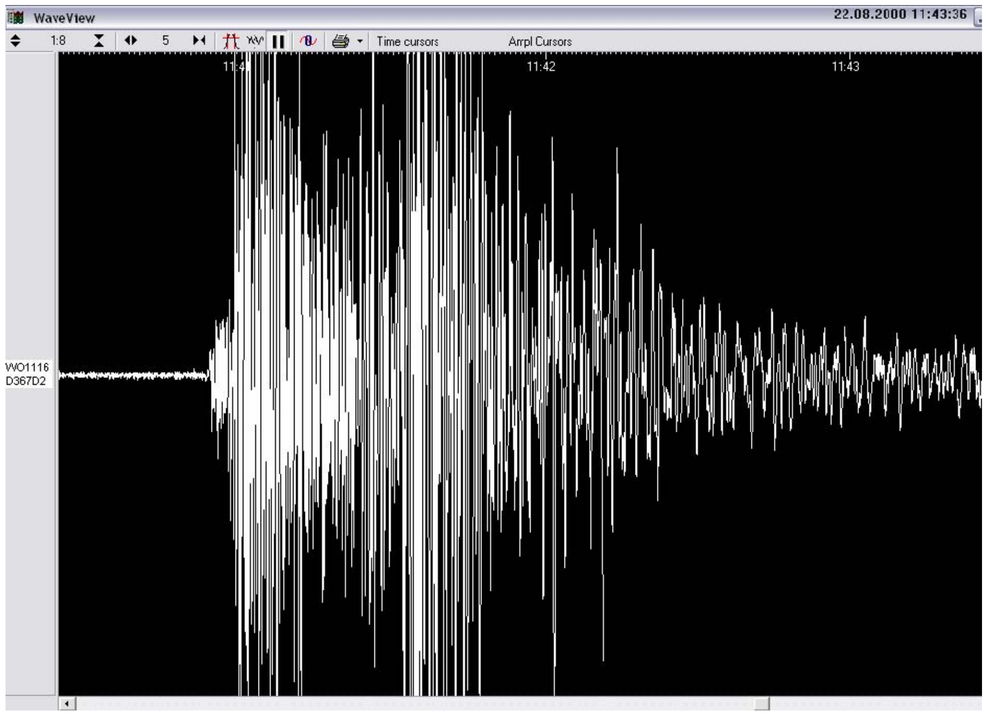

Figure 14. The digital record (with decreased amplitude) of the 2000.08.22 Uruş earthquake from Boyabat station (BYT); it is visualised by using **S**cream **C**onfugration **RE**altime **A**cqusition and **M**onitoring **(SCREAM)** programme.

Figure 15. First motion of P wave recorded by İznik station (IZI) (2000.08.22 Uruş earthquake).

Table 4. Earthquake recording stations of Boğazciçi University Kandilli Observatory Laboratory and Earthquake Research Institute, as well as, a part of the station list of AZMTAK and PINV programme.

NUMBER		METHOD	Kod	N°	E°	Z (m)
1	1	**BROAD-BAND**	**BALB**	3938.4	2752.8	120
2	2		**EDRB**	4150.82	2644.62	209
3	3		**ISKB**	4103.94	2903.55	132
4	4		**ISP**	3749.36	3031.33	1000
5	5		**MALT**	3818.78	3825.62	1087
6	6		**SVSB**	3954.94	3659.52	1630
7	7		**VANB**	3835.7	4323.33	1227
8	1	**ON-LINE**	**ALT**	3903.31	3006.62	1060
9	2		**ARI**	3936.53	4259.22	1440
10	3		**BCK**	3727.66	3035.26	859
11	4		**BNG**	3852.55	4029.34	1100
12	5		**BNN**	3851.13	3550.83	1380
13	6		**BYBT**	4128.11	3446	330
14	7		**BTM**	3806.89	4117.61	854
15	8		**BZK**	4157.8	3400.21	70
16	9		**CEY**	3700.64	3544.87	100
17	10		**CAN**	4036.29	3337.18	815
18	11		**DEN**	3745.22	2901.99	637
19	12		**DST**	3936.24	2837.15	625
20	13		**DYB**	3753.91	4013.58	657
21	14		**EDC**	4020.81	2751.8	269
22	15		**ELL**	3644.9	2954.51	1230
23	16		**ERZ**	3945.12	3921.2	1500
24	17		**ESK**	3931.33	3050.98	1289
25	18		**EZN**	3949.55	2619.52	49
26	19		**GAZ**	3710.33	3712.68	864
27	20		**GPA**	4017.15	3019.03	572
28	21		**GUM**	4028.05	3928.68	1326
29	22		**HTY**	3607.27	3608.27	84
30	23		**IKL**	3614.32	3341.11	120
31	24		**IZM**	3823.87	2715.75	631
32	25		**KAM**	3922.15	3342.76	1161
33	26		**KHL**	3819.39	2931.39	940
34	27		**KIZ**	3852.9	3153	1202
35	28		**KON**	3756.72	3221.63	550
36	29		**KRS**	4037.66	4304.73	1450
37	30		**KVT**	4104.84	3602.78	649
38	31		**LEF**	3507.16	3253.42	150
39	32		**LOD**	3953.36	3245.84	902
40	33		**MUD**	4027.92	3112.87	1110
41	34		**MYA**	3819.57	3825.52	1050
42	35		**NIG**	3806.53	3436.87	2291
43	36		**ORL**	4002.77	2853.75	649
44	37		**SAF**	4114.39	3241.23	406
45	38		**TOK**	4019.04	3632.67	726
46	39		**TOS**	4102.17	3401.35	1046
47	40		**VAN**	3826.7	4323.33	1750
48	41		**YER**	3708.17	2817.15	729
49	42		**YOZ**	3938.3	3518.92	1422

continued →

NUMBER		METHOD	Kod	N°	E°	Z (m)
50	1	**TELEMETRİ**	**AMT**	4033.94	2851.7	418
51	2		**BAD**	4051.14	2907.05	175
52	3		**BEY**	4109.55	2917.45	153
53	4		**BNT**	4021.36	2755.2	353
54	5		**CTT**	4108.84	2825.78	324
55	6		**EYL**	4033.96	3009.45	1160
56	7		**HRT**	4049.3	2940.08	645
57	8		**IZI**	4020.21	2928.37	910
58	9		**KGT**	4027.09	2718.2	185
59	10		**KCT**	4015.93	2821.39	451
60	11		**LAP**	4022.36	2645.61	200
61	12		**MFT**	4047.2	2716.87	924
62	13		**YLV**	4034	2922.37	829
63	1	**TELE-METRİ (nmx)**	**CTBX**	4120.53	2821.46	378
64	2		**HRTX**	4049.3	2940.08	645
65	3		**KCTX**	4015.93	2821.39	451
66	4		**MFTX**	4047.2	2716.87	924
67	5		**MRMX**	4036.35	2735.02	702
68	6		**YLVX**	4034	2922.34	829
69	1	**STABLE**	**BCA**	4126.7	4137.34	500
70	2		**LFK**	3516.75	3331.95	690
71	3		**MGS**	3506	3331.2	400

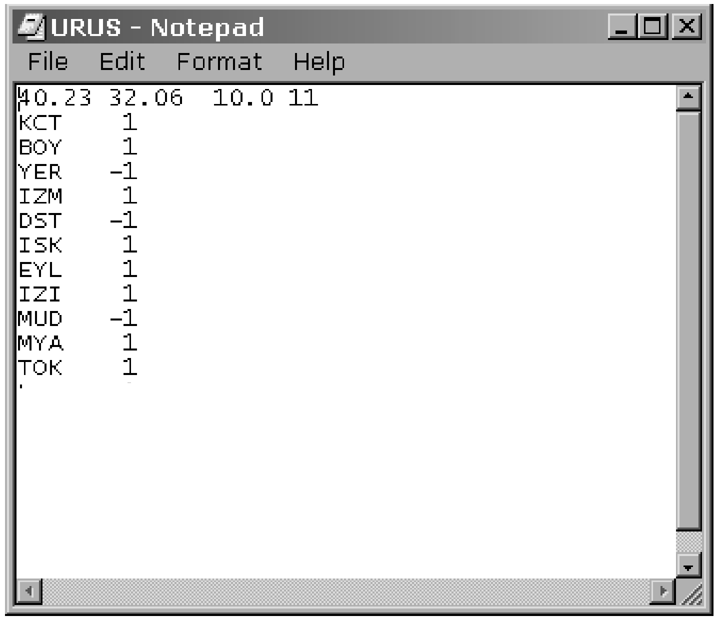

Figure 16. The ‘dat’ file belong to the 2000.08.22 Uruş earthquake which includes station names, polarities of wavelengths, coordinates of earthquakes, depth of focus and the number of stations.

In order to use this file, of which extension is .dat, for the fault plane solution, the AZMTAK program is run firstly. AZMTAK constitute another file, which extension is ‘out’, by using the ‘dat’ file and another file, which involves the stations’ information (Table 4).

In order to do fault plane solution of the 2000.08.22 Uruş Earthquake, the data coming from stations of KOERI were used in terms of the fault plane solution programmes explained above.

When PINV is run, the out file, which is constituted by AZMTAK, is used and fault plane solution is concluded (Figures 17, 18, 19).

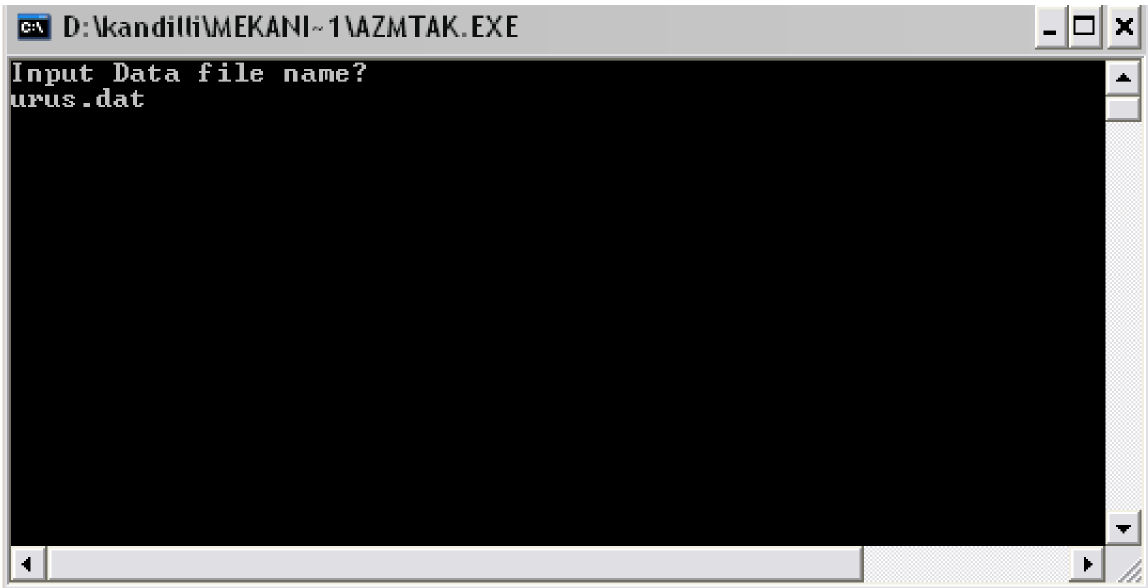

Figure 17. First step in Fault Plane Solution-the use of AZMTAK proramme software.

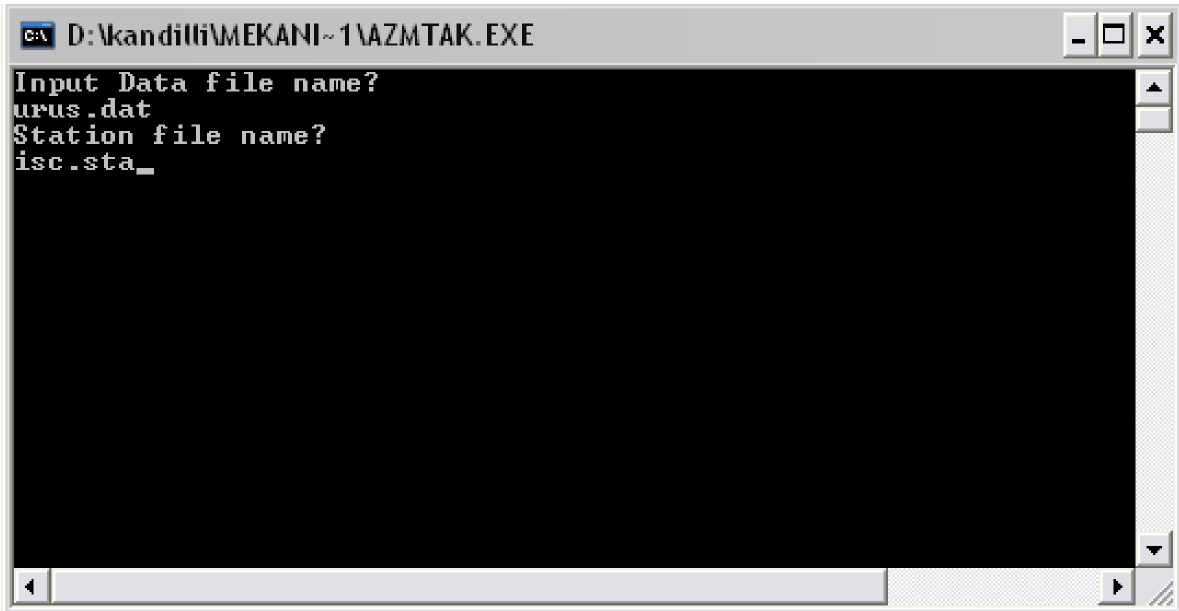

Figure 18. Second step in the AZMTAK proramme.

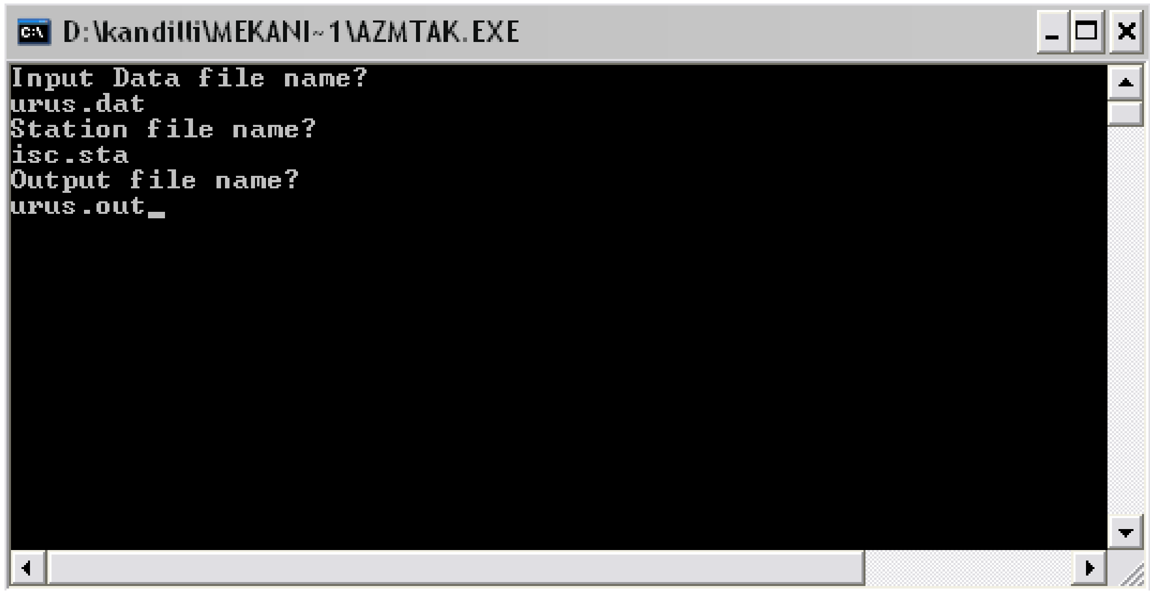

Figure 19. Third step of AZMTAK programme.

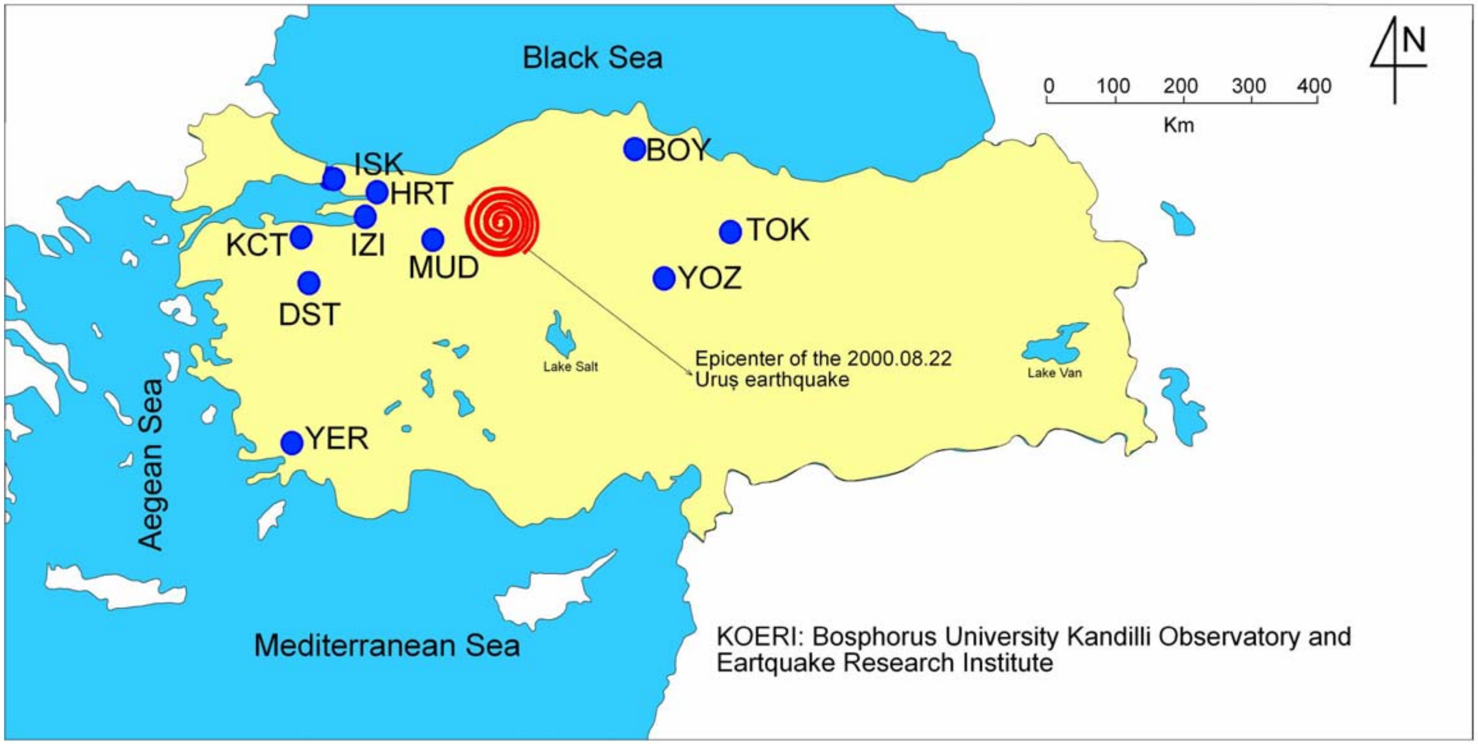

Figure 20. Map showing epicenter of the 2000.08.22 Uruş earthquake and the locations of recording stations.

Two fault plane solutions were performed for the 2000.08.22 Uruş earthquake for main shock and an aftershock recorded separately by KOERI (Table 3). The main shock has Md=4.3 which epicentral coordinates of 40.23° N-32.06° E. The fault plane solution reveals that the source of the Uruş earthquake is a sinistral strike-slip faulting with considerable amount of reverse component (Figure 21). The second fault plane solution for an aftershock recorded also by KOERI which has the Md=3.8 and epicenter

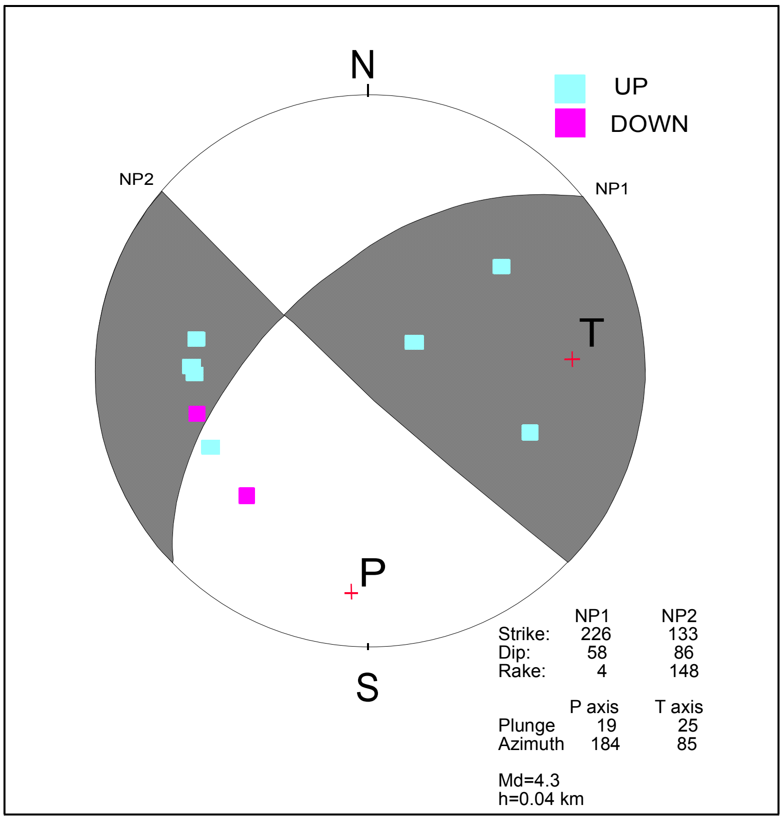

Figure 21. Fault plane solution of the 2000.08.22 Uruş earthquake (KOERI: main shock)

coordinates of 40.19° N-32.02° E. this solution shows a reverse faulting with a considerable amount of sinistral strike-slip component for the source of the greatest aftershock (Figure 22). In both fault plane solutions, Nodal Plane 1 (NP1) fits quite well with the planar attitudes of the master fault of the Uruş fault set (Figures 3, 21, 22). The NP1 in the first solution indicates that the Macun-Kabaca section of the master fault may have reactivated (Figure 3, 21). However, the NP1 in the second solution indicates the ENE-trending Kabaca-Kırkkavak section of the Uruş fault set has reactivated (Figures 3, 22).

Table 5. Data of the 2000.08.22 Uruş earthquake.

Date	2000.08.22
Origin	11:40:12.32
Latitude	40.227
Longitude	32.06
Depth	10 km
Magnitude	4.3
Data number	9
GAP	135
Nearest station distance	76.6 km
RMS	1.01
Distance mistake	4.7
Depth mistake	0.7
Quality	D1

Consequently it is suggested that the 2000.08.22 Uruş earthquake was originated from the master fault of the Uruş fault set. As explained in foregoing chapter, the northern margin-bounding fault, namely the Uruş fault set is active, and its nature is changing along its length. It is a left lateral strike-slip fault with reverse component where it strikes NE, while it is a reverse fault with sinistral strike-slip component where it strikes ENE (Figures 3, 21, 22).this was confirmed once more by focal mechanism solutions as well as the morphotecronic markers explained in foregoing chapters.

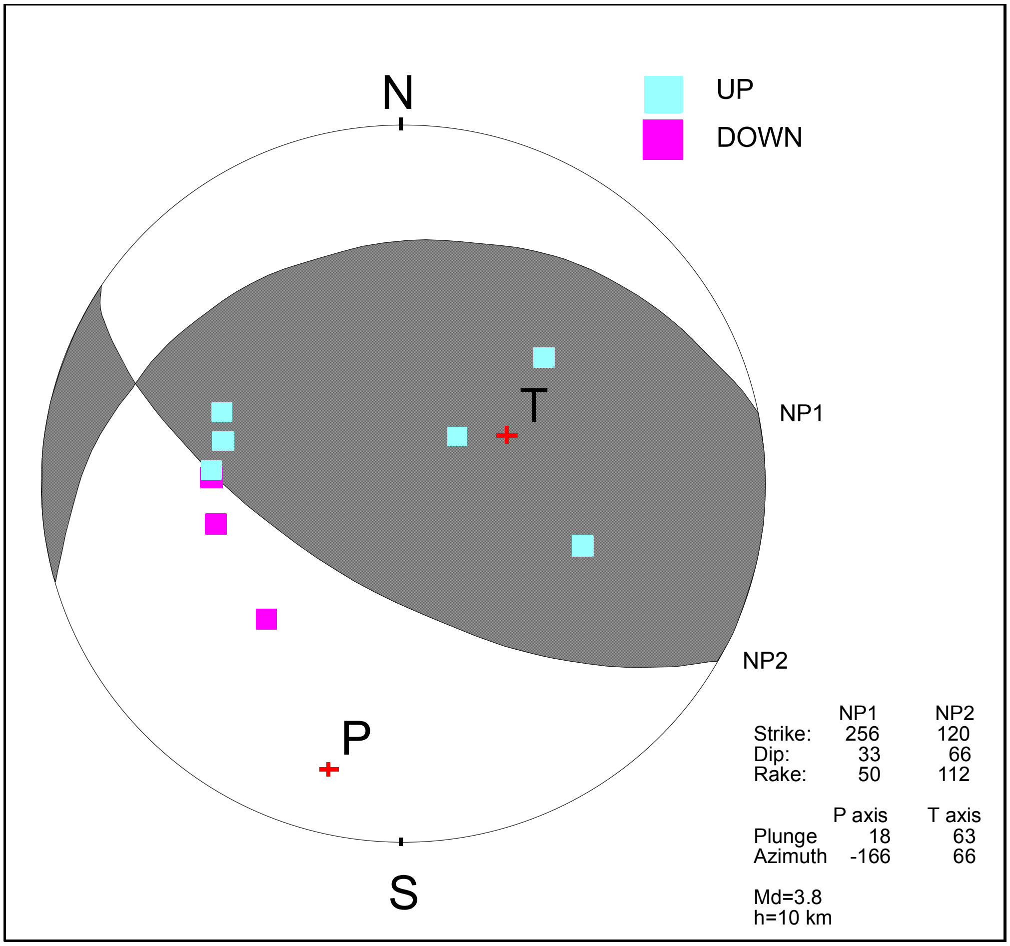

Figure 22. Fault plane solution of the 2000.08.22 Uruş earthquake (KOERI).

4.2.7. 2003.02.27 Çamlıdere (Ankara) Earthquake

A small-magnitude (Md=4.0 or Ml=3.8) and shallow-focus (8.05 m or 2.1 km) earthquake struck on February 27, 2003, at 18:36:56.23 (GMT) (KOERI 2003; ERD 2003). The instrumental coordinates of this earthquake were declared to be 40.46°N-32.46°E by KOERI (2003), and 40.43°N-32.52°E by ERD (2003). This seismic event was also felt in Ankara and its close vicinity such as Kızılcahamam, Çeltikçi, Güdül, Uruş, Beypazarı, Ayaş, Kazan and a number of villages. The earthquake was felt strongly and caused rock falls in the Çamlıdere county but no severe damage or loss of live was reported.

The main shock was followed by a series of smaller aftershocks. Seven of these aftershocks and main shock recorded by KOERI (2003) and ERD (2003) (Figure 23) are listed on (Table 7).

The instrumental epicenter of the 2003.02.27 Çamlıdere earthquake is located 5 km south-southwest of Çamlıdere County and at the intersection between the E-W-trending Bayındır Fault Zone and the NE-trending Çeltikçi Fault Zone (Figures 10, 11).

4.2.7.1. Fault Plane Solution of 2003.02.27 Çamlıdere (Ankara) Earthquake

Various parameters related to this earthquake are listed on Table 6. The Çamlıdere earthquake was recorded by 20 stations (Figure 23). Ten of them have clear first motion of P waves; they are used for fault plane solution to determine the source of the 2003.02.27 Çamlıdere earthquake. The fault plane solution revealed that the origin of the 2003.02.27 Çamlıdere earthquake is an oblique-slip normal faulting with considerable amount of left-lateral strike-slip component (Figure 24).

Planar attitudes of both the Nodal Planes 1 and 2 (Figure 24) fit well with fault segments comprising the Peçenek Fault Zone about 5-km-wide, 13-km-long, approximately WNW-trending zone of deformation, consisting E-W -, NW- and NE-trending step-like oblique-slip fault segments. Each segment has a length of 0.7 to 9 km and dips NNE and SSW directions. They controlled the formation of graben-horst structures. The longest (9 km) one is the Bayındır Fault. In general, the fault trends in WNW direction, but it bends in SE direction and gains a NW trend along its eastern half, where it bifurcates into three splays. They trend NW and dip in NE direction. The Nodal Plane 1 (NP1) in the fault plane solution fits quite well with these splay and their oblique-slip normal faults nature. Thus the source of the 2003.02.27 Çamlıdere earthquake may be attributed to the reactivation of one of these

Table 6. Various seismic parameters of 2003.02.27 Çamlıdere Earthquake and its some aftershocks (KOERI 2003, ERD 2003).

Date	Origin Time (GMT)	Location Lat.N-Long.E	Focal Depth Km	Magnitude	Fault Plane sol. strike/dip/rake	Geographical Region Site	Reference
2003-02-27	18:36:56.25	40.46-32.46	8.05	Md=4	1.226°/ 58°/ 4°	Çamlıdere (Ankara)	KOERI and this study
					2.133°/ 86°/ 148°		
2003-02-27	18:36:58.0	40.43-32.52	2.1	Ml=3.8	-	Çamlıdere (Ankara)	ERD
2003-02-27	19:00:50.60	40.41-32.55	2	3.2	-	Çamlıdere (Ankara)	ERD
2003-02-27	20:47:53.11	40.39-32.50	3.8	2.9	-	Çamlıdere (Ankara)	ERD
2003-02-27	21:41:46.45	40.36-32.48	6	2.7	-	Çamlıdere (Ankara)	ERD
2003-02-28	22:35:24.66	40.38-32.57	3	2.9	-	Çamlıdere (Ankara)	ERD
2003-03-02	16:26:16.15	40.37-32.52	6.6	2.8	-	Çamlıdere (Ankara)	ERD
2003-03-03	00:38:39.61	40.39-32.53	5.9	2.8	-	Çamlıdere (Ankara)	ERD
2003-03-11	22:51:42.57	40.32-32.48	6.7	2.7	-	Çamlıdere (Ankara)	ERD

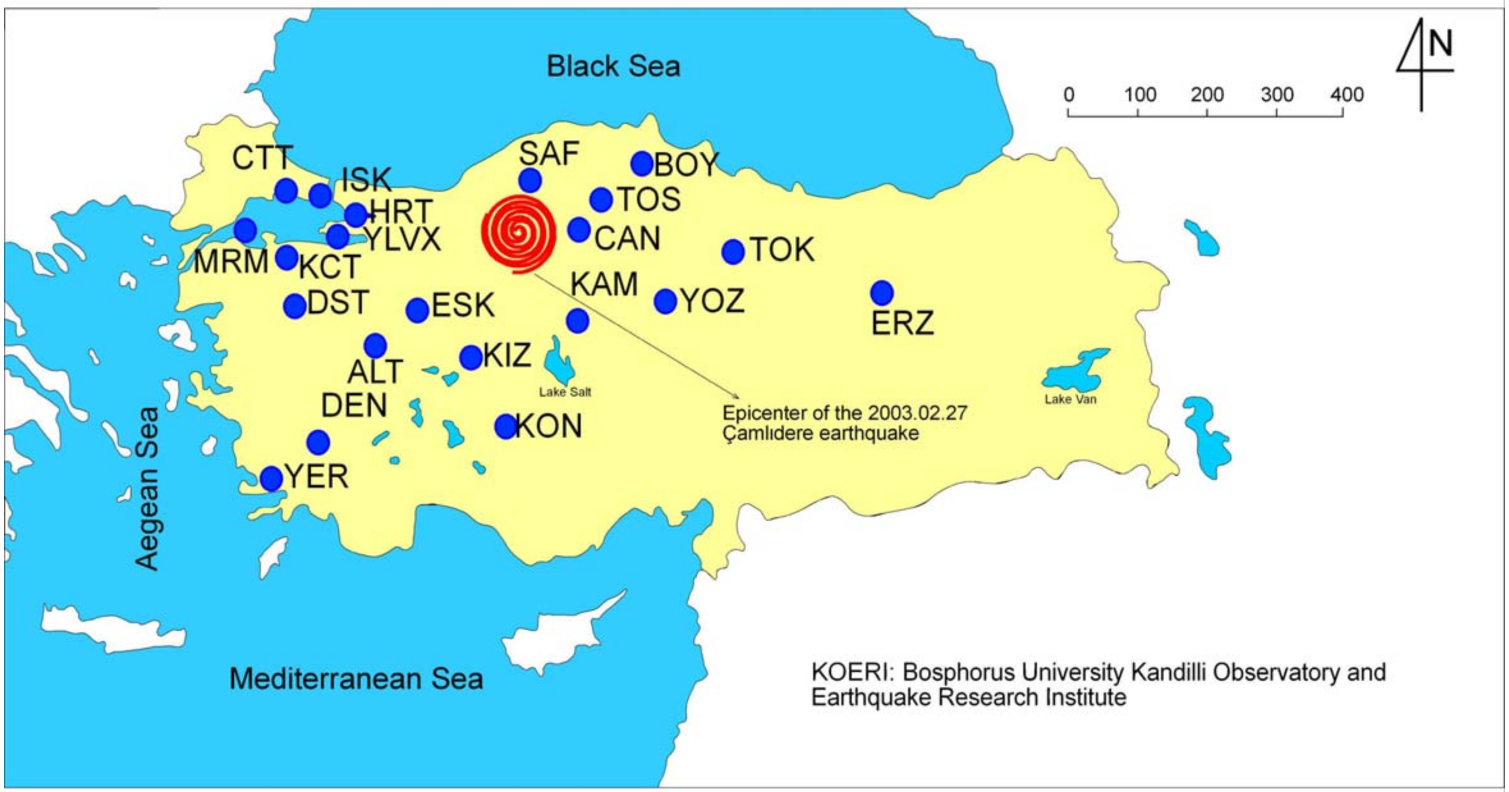

Figure 23. Map showing epicenter of the 2003.02.27 Çamlıdere earthquake and the locations of earthquake recording stations.

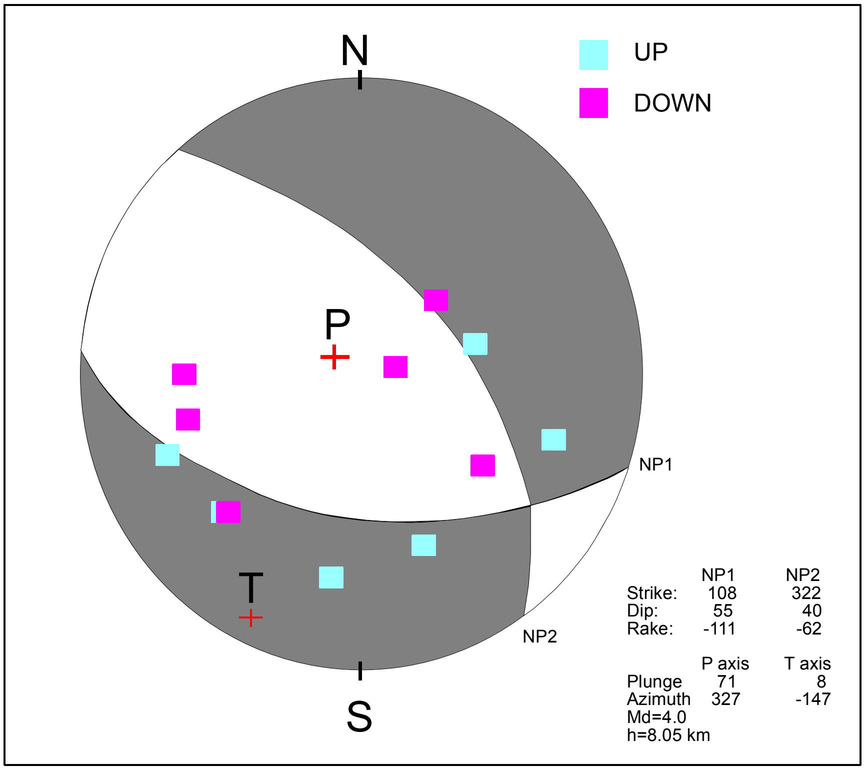

Figure 24. Fault plane solution of the 2003.02.27 Çamlıdere (Ankara) earthquake.

three oblique-slip normal fault segment (Figures 10, 11 and 24).

Table 7. General results of the Çamlıdere (Ankara) earthquake (KOERI).

Date	2003.02.27
Time	18:36:56.25
Latitude	40°.461 N
Longitude	32°.465 E
Depth	8.05 km
Magnitude	4.0 (Md)
Data number	22
GAP	135
Nearest station distance	88.5 km
RMS	0.49
Distance mistake	2.2
Depth mistake	0.6
Quality	D1

4.3. Role of Ground Material in Seismic Damage in Ankara

In general, the city center of Ankara and its major counties are located in an 18-20 km long, 6-8 km wide and approximately E-W-trending depression bounded by some isolated mountains and plateaus such as Çiçekdağ and Tekkedağ in the north, Elmadağ in the ESE, Çaldağ and Ahlatlıbel plateau in the south, and Neşedaş in the west (Figure 25). This depression drained by the westward flowing Ankara River and its subbranches emanating from crests of mountains and plateau and flowing towards south and north inside the depression. The Ankara River has a wide (up to 3 km) and densely populated flood plain at present.

From the point of view of construction, the ground material comprising site of city of Ankara can be grouped into three basic categories: (1) pre-Pliocene basement rocks, (2) Pliocene fluvio-lacustrine sedimentary sequence, and (3) Plio-Quaternary terrace and alluvial deposits (Figure 25).

4.3.1. Basement Rocks

The areas seen in white on the map (Figure 25) are composed of strongly consolidated and lithified basement rocks or bedrocks such as the Triassic Karakaya Rock assemblage, Liassic-Lower Cretaceous sedimentary sequence, Upper Cretaceous ophiolitic melange, Upper Cretaceous-Lower Eocene shallow- to deep-marine sedimentary sequence and Paleocene-Miocene volcanic rocks (Koçyiğit 1987, 1991; Koçyiğit et al. 2003). Especially the graywackes comprising the Karakaya Rock Assemblage, and the various lithologies comprising the ophiolitic melange are intensely crushed, brecciated and cut across by shear planes, i.e. they are full of planes of weakness. In addition, volcanic rocks are mostly andesitic in composition, they are mostly cut by conjugate shear planes, most of which have been widened and filled by secondary clay minerals; ie. both physical and chemical weathering are extensive. Locally, average maximum stress of this group of rocks has been calculated to be 4 kg/cm^2 (Tabban 1976).

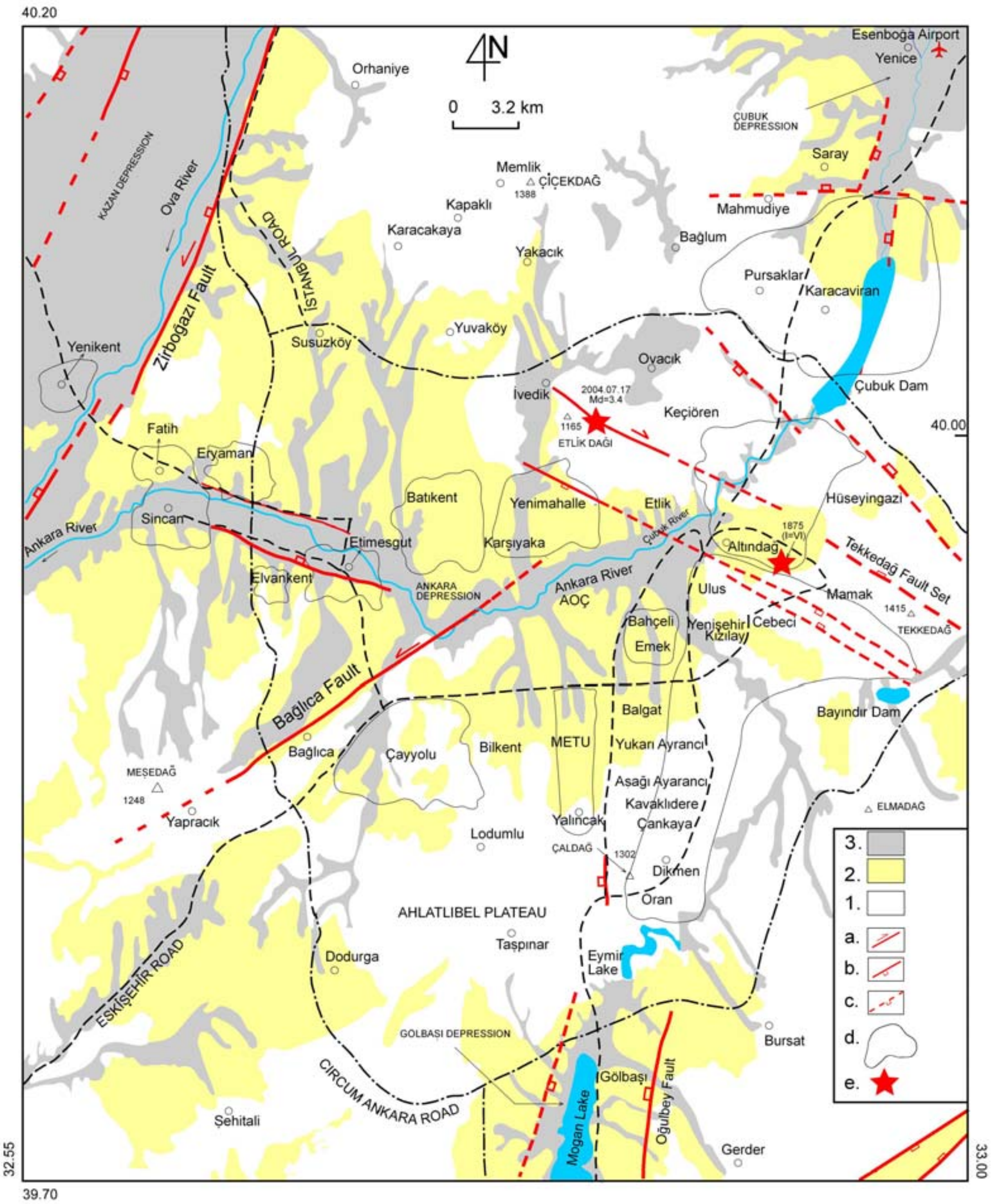

Figure 25. Simplified geologic map illustrating type of ground material underlying settlements. 1. Pre-Pliocene basement rocks, 2. Pliocene fluvio-lacustrine sedimentary sequence, 3. Quaternary alluvial deposits; a. sinistral strike-slip fault, b. sinistral strike-slip fault with normal component (rectangle on downthrown block), c. probable fault, d. approximate outline of some settlements counties) included in Ankara, e. epicenter of earthquake.

The settlements such as Ulus, Mamak, Cebeci, Keçiören, some parts of Yenimahalle, Yukarı-Aşağı Ayrancı, Kavaklıdere,Çankaya, Dikmen, Oran and some parts of Çayyolu, are located mostly on the basement rocks, and these settlements are relatively safe places with respect to other areas. However, Ulus, Mamak and Altındağ are underlain by highly fractured andesitic volcanics. These widened and secondary clay-filled shear fractures may act as slip-planes and may cause rock fall and other mass-wasting processes. This may lead to severe damage to structures during ground shaking or the time of any earthquake.

4.3.2. Fluvio-Lacustrine Sedimentary Sequence

This is the most widespread fill of the Ankara depression (Koçyiğit and Türkmenoğlu 1991). This sedimentary unit, which is seen in yellow colour on the map (Figure 25), from bottom to top, consists of three basic lithofacies: (a) 1-53-m-thick and unsorted alluvial fan conglomerate, (b) 5-10-m-thick braided river conglomerate-sandstone, and (c) 75-100-m-thick fine-grained sandstone-silt-stone, mudstone and shale alternation with lensoidal channel conglomerate intercalations. This last lithofacies accumulated in flood plain is also dominated by $CaCO_3$ concretions and full of syndepositional growth faults. It is also rich in secondary clay minerals such as smectite and illite derived from the alteration of underlying basement rocks. Therefore, the red, fine-grained and clay-rich mudstone and shale in Ankara depression have been termed erroneously ‘Ankara clay formation’ by Civil Engineers. Upper part of the Pliocene fluvio-lacustrine sedimentary sequence is also cut across by a series of shear planes. The clay-rich levels are impermeable and display plastic behaviour against the overlying static load imposed by mostly tall buildings. On the other, hand very porous and lensoidal channel conglomerates, which occur at different stratigraphical horizons, act to be perched water levels. Finally, several meters long growth faults and shear planes cutting across these two facies act as planes of weakness, which may reactivate and trigger a motion themselves as a natural response to ground shaking or high static overload imposed by tall buildings or other constructions. This is confirmed frequently by differential slumping, tilting and formation of open cracks across the walls of some buildings constructed on this type of ground material in Ankara region. This is one of a serious settlement problems for most of residents in Ankara. Average maximum strength of this ground material has been calculated to be 1-3 kg/cm^2 (Tabban 1976). The settlements, such as Yenişehir, Maltepe, Bahçeli, Emek, Balgat, Yüzüncüyıl, Atatürk Orman Çiftliği, Middle East Technical University Campus, Karşıyaka, Batıkent and Eryaman, constructed on this type of ground has very widespread foundation problems and they are much more open to risk of ground shaking than the first category of ground material basement rocks during seismic activity (Figure 25).

4.3.3. Terrace and Alluvial Sediments

This is the weakest ground material overlain by settlements. It is shown in grey colour on the map (Figure 25). It was accumulated on flood plains of large drainage system such as the Ankara River, the Çubuk River, the Ova River, and along the beds of subbranches of these major drainage systems. Quaternary alluvial sediments are also widespread fills of fault-bounded depressions such as the Kazan, Çubuk and Gölbaşı basins (Figure 25).

The Ankara River has a wide (up to 3 km) flood plain surrounded by river to fault terraces, which are the deformed, uplifted and eroded remnants of ancient river deposits. Both the terraces and flood plains are composed of unsorted, loose and all-sized sediments, such as boulder, gravel, pebble, sand and silt. However, near by the depocenter (area away from margins of basins or flood plains) sediments grade into fine-grained and organic material-rich silt, mud and clay, in places. The thicknesses of these alluvial sediments range from 10 m in Güvercinlik nearby Atatürk Orman Çiftliği to

>200 m in the south of Yenimahalle county (Figure 26) (Tabban 1976). The average thickness of these unconsolidated Quaternary alluvial sediments is 42 m. The static water level within these sediments also varies from 0.6 m to 17 m below the ground surface, and as an average of 6 m. The maximum strength of the alluvial sediments was calculated to be 1 kg/cm^2 (Tabban 1976). In addition, periods of seismic waves across these three categories of ground materials underlying Ankara are 0.2-0.3/second, 0.5-0.6/second, and 0.7-0.8/second, respectively.

At present, the most of the weakest, unconsolidated and water/saturated fine-grained Quaternary sediments with long wave period were densely populated. The most of city center of Ankara and its major counties are underlain by these alluvial sediments. There fore, they are much more open to the primary effects (ground shaking, ground amplification) and secondary effects, such as local liquefaction, than other settlements during earthquakes.

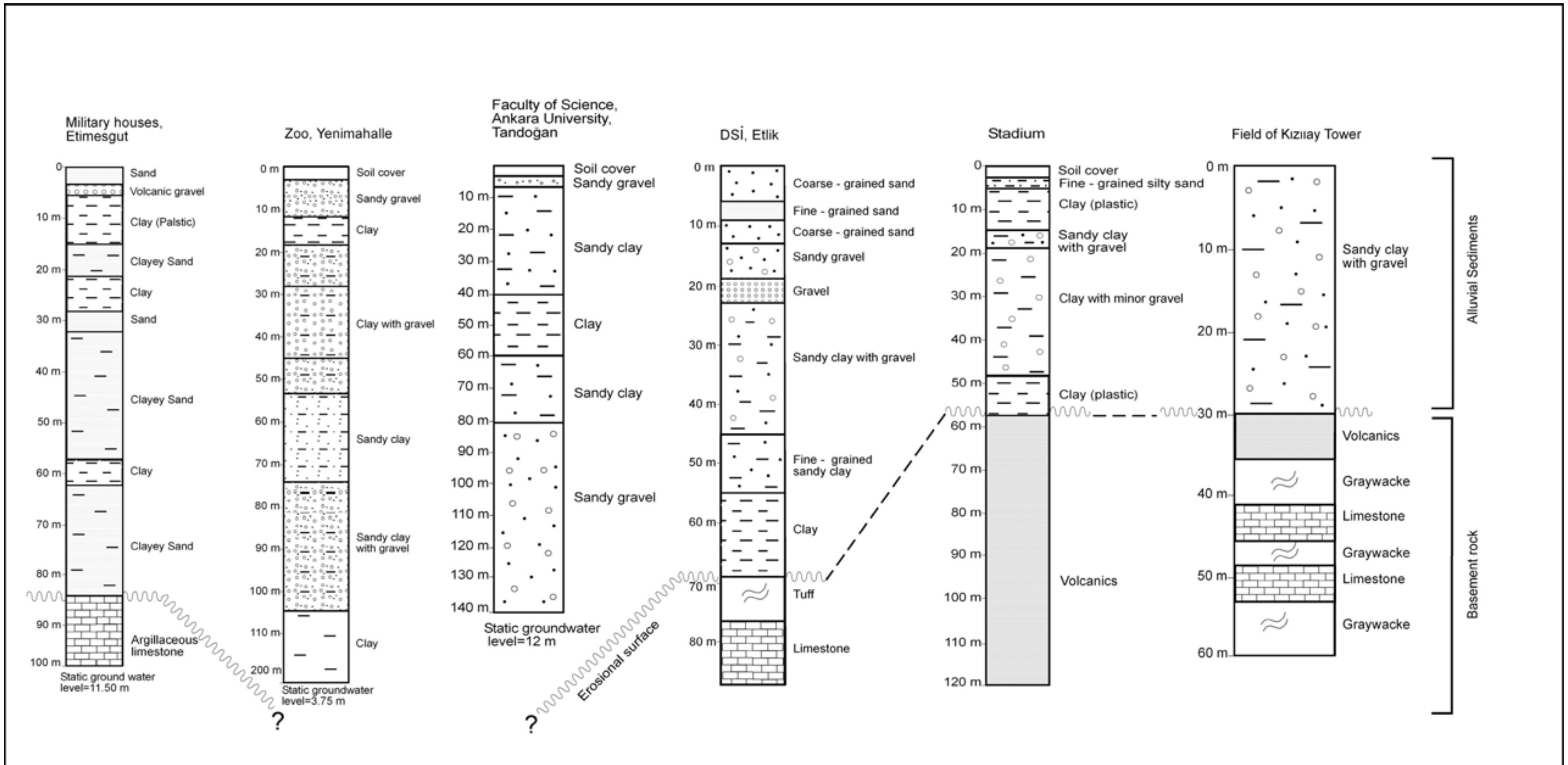

Figure 26. Correlative boreholes drilled at different locations across the flood plain of the Ankara River (Tabban, 1976).

CHAPTER 5

CONCLUSION

In terms of this study carried out in the frame of a MSc. Thesis, the followings are concluded:

1. Ankara region and its vicinity are characterized by intermediate to small earthquakes with magnitudes ≤6.
2. Source of the earthquakes in Ankara region are: (a) NE-trending sinistral strike-slip faults with normal slip component, (b) NE- and NW-trending oblique-slip normal faults with considerable amount strike-slip components, (c) ENE-trending reverse faulting with considerable strike-slip component.
3. There are a number short but active faults in the Ankara region. These are mostly the NE-, NW-, WNW-, ENE- and NNE-trending faults. Most of these faults are oblique-slip in natural and they represent a transitional zone of deformation between the right-lateral simple shear zone, namely the North Anatolian Right-Lateral Strike-slip Fault System defining a relevant strike-slip neotectonic regime in the north and oblique-slip normal faults characterizing an extensional neotectonic regime in the south.
4. Ankara region has been divided into a series of highlands and linear-narrow depressions (basins) by the oblique-slip faults. Some of these depressions are Kazan, Çubuk, Gölbaşı, Çeltikçi and Peçenek basins.
5. The northern margin-bounding faults of the Çeltikçi active basin has been main of the scope of this work. The Macun-Karacaviran section of the Çeltikçi Fault Zone was mapped at 1/25.000 scale, and a neotectonic map of this area, namely the Uruş area, was prepared for the first time.
6. The 2000.08.22 Uruş and the 2003.02.27 Çamlıdere earthquakes originated from the Çeltikçi and Bayındır fault zones were analyzed in terms

of fault plane solutions. Focal mechanisms solutions revealed that the 2000 Uruş Earthquake have originated from the activations of both the NE- and ENE-trending sections of the master fault of the Uruş fault set. This is confirmed by two fault plane solutions pointing out a left-lateral strike-slip faulting with reverse component, and a reverse faulting with left lateral strike-slip component. This conclusion implies variations in the nature of the fault when its general trend changes. In the same way, fault plane solution of the Çamlıdere earthquake pointed out that they have been sourced from the oblique-slip normal faulting with minor sinistral strike-slip component. Thus, activeness and type, the northern margin-bounding faults, namely the Uruş fault set, of the Çeltikçi depression were determined by both morphotectonic features and seismic events.

7. A survey on earthquake catalogues indicated that no historical earthquake had occurred in the Ankara region. However, the city center of Ankara and its smaller settlements such as Beypazarı, Ayaş, Güdül, Kızılcahamam, Çubuk and Kazan counties were affected by big destructive historical and recent earthquakes originated from the North Anatolian Fault System and the Seyfe Fault Zone located 110 km and 80 km away from the city center of Ankara. These destructive earthquakes are the 1668 Bolu-Katamonu-Amasya, the 1944 Çerkeş-Gerede and the 1938 Akpınar-Taşkovan (Kırşehir) earthquakes.

8. Small-magnitude (M≤5) and shallow-focus earthquakes occur frequently in Ankara region. This is confirmed by the epicenter distribution of earthquakes recorded in the period of 1900-2004. Some of these small earthquakes (e.g., the 2000.08.22 Uruş earthquake) caused severe damage to not only '*hımış*' type structures but also to concrete buildings as well. The role of ground material in this seismic damage was also observed.

9. From the point of view of construction, ground material underlying the city of Ankara was divided into three categories: (a) well-lithified basement rocks, (b) Pliocene fluvio-lacustrine sedimentary sequence, and (c) unconsolidated terrace and alluvial sediments of Quaternary age. Average maximum

strength of these ground materials are 4 kg/cm^2, 1-3 kg/cm^2 and 1 kg/cm^2, respectively. In addition first two groups of ground materials are cut across by widened shear planes and cracks filled by secondary mineralization. These planes of weakness may trigger the motion along themselves during ground shaking, or as a natural response to high static overload imposed by the tall buildings constructed on these types of materials.

10. Quaternary unconsolidated sediments are densely populated in Ankara. These fine-grained sediments and have a maximum thickness of 200 m or more. Inside these sediments, static ground water level is very close to ground surface (as on average: 6 m). These conditions are quite suitable for liquefaction of unconsolidated alluvial sediments. In the same way, periods of seismic waves through these sediments are also very long (0.7-0.8/second). Thus, the external role of alluvial sediments in seismic damage to structures will be high than other ground materials.

11. On the contrary of the previously and erroneously reported idea that the seismicity in Ankara region is very low and it can be neglected in construction, it is quite high and may cause severe damage to all kinds of structures as indicated once more by the 2000.08.22 Uruş earthquake. Therefore, the active faults, liquefaction capacity of unconsolidated alluvial sediments with low maximum strength and long period and primary and secondary planes of weakness in lithified basement rocks have to be taken into account for engineering constructions not only in Ankara but also elsewhere too.

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APPENDIX

Table 1. Seismic parameters of the earthquakes occured in the period of 1918-2004 which were used for epicenter distribution of the Ankara region between 46-41.0 N° 31.95-34.0 E° coordinates (KOERI).

	Date	Origin (GMT)	Epicenter N°	Epicenter E°	Depth	Magnitude	
1	1918-01-16	16:32:01	38.8	32.9	0	5.3	
2	1918-08-09	00:39:10	40.89	33.41		5.8	
3	1919-06-09	15:47:17	40.68	33.89	10	5	
4	1928-10-03	00:57:08	40.47	33.42	70	5	
5	1928-10-04	11:14:08	40.22	33.67	10	5.7	
6	1931-01-12	15:55:31	38.47	32.42	60	4.9	
7	1933-05-26	23:54:45	40.71	33.96	10	4.2	
8	1933-06-28	11:54:39	39.3	33.2	0	4.7	
9	1935-07-12	02:30:00	40.6	33.6	0	4.8	
10	1936-09-22	11:56:56	40.98	33.26	60	4.8	
11	**1938-04-19**	**10:59:20**	**39.44**	**33.79**	**10**	**6.6**	**Kırşehir earthquake; Jackson&McKenzie, 1984**
12	1938-04-19	23:11:18	39.65	33.87	30	5	
13	1938-05-14	04:45:53	39.74	33.55	10	4.8	
14	1938-05-14	06:55:02	39.5	33.7	0	4.7	
15	1938-05-28	00:05:00	39.5	33.81	30	4.9	
16	1938-05-31	17:55:22	40.9	33.73	10	4.9	
17	1938-07-21	21:56:06	39.56	33.68	10	5	
18	1938-12-16	11:03:03	39.52	33.91	10	4.8	
19	1938-12-23	01:32:03	39.5	33.5	0	4.2	
20	1940-10-11	01:37:13	40.81	33.3	10	4.9	
21	1943-11-27	23:29:38	40.78	33.93	40	4.9	
22	1944-10-18	12:54:05	40.89	33.47	10	5.2	
23	1947-12-19	17:31:18	40.71	32.82	10	5.1	
24	1949-05-13	20:14:01	40.74	32.71	20	5.1	
25	**1951-08-13**	**18:33:34**	**40.88**	**32.87**	**10**	**6.9**	**Çerkeş earthquake; Canıtez&Büyükaşıkoğlu, 1984**
26	1951-08-14	20:23:12	40.82	33.23	10	4.8	
27	1958-05-21	10:13:01	40.65	33.36	10	4.6	
28	1959-01-05	04:54:02	40.83	32.25	40	4.2	
29	1961-06-03	06:16:16	39.33	32.64	10	4.3	
30	1961-12-05	01:21:15	40.62	32.62	1	1	
31	1964-06-19	00:50:25	40.74	32.83	0	4.6	
32	1964-08-28	22:56:01	38.5	32.5	17	1	
33	1967-06-22	07:25:02	40.82	33.9	17	4.2	
34	1967-06-22	10:24:04	40.88	33.7	33	3.7	
35	1967-06-22	12:18:05	40.83	33.6	13	4.3	
36	1967-06-23	10:06:55	40.85	33.65	20	4.4	
37	1968-06-18	10:09:02	40	33	33	4.2	
38	1968-09-26	06:42:03	38.76	32.6	40	4.5	
39	1968-10-06	22:07:11	38.78	32.59	37	4.8	
40	1970-04-27	09:34:03	38.98	32.02	32	4.3	
41	1971-05-14	06:00:19	38.7	32.3	33	1	
42	1971-07-08	18:28:00	40.56	32.9	0	3.9	
43	1971-07-17	20:51:00	40.1	32.1	0	3.1	
44	1972-08-09	09:40:53	39.5	32.4	33	1	

continued →

45	1973-02-19	18:10:02	40.28	33.86	22	4.7
46	1973-04-27	00:31:03	38.65	32.92	29	4.6
47	1973-10-21	22:50:31	40.7	32.4	5	3.7
48	1974-05-17	13:04:16	39.5	32.3	0	1
49	1974-08-30	05:43:18	40.8	33.9	0	3.5
50	1975-05-01	12:29:58	40.6	33.8	0	3.8
51	1975-06-27	00:20:38	39.56	32.03	0	3.6
52	1975-07-30	16:25:17	39.45	32.13	2	4.5
53	1975-07-31	02:58:15	39.46	32.1	0	3.2
54	1975-08-30	18:54:02	40.8	33.4	5	3.7
55	1975-09-22	12:56:00	40.36	33.4	3	4.4
56	1975-09-22	16:31:05	40.26	33.34	18	4.1
57	1975-12-27	00:52:02	40.33	32.7	0	1
58	1976-06-15	18:00:56	38.82	32.31	0	4.1
59	1976-10-31	21:17:49	40.7	33.4	0	3.6
60	1976-11-11	14:20:44	39.3	32.9	33	3.6
61	1977-02-23	03:36:42	40.9	33.8	0	3.6
62	1977-04-24	20:49:06	39.2	33.5	0	3.1
63	1977-05-07	13:57:18	40.3	32.48	0	2.8
64	1977-05-10	22:16:08	40.37	33.07	0	3.4
65	1977-07-01	19:13:44	39	33.7	0	1
66	1977-07-05	22:36:36	40.4	32.8	0	2.9
67	1978-01-23	21:00:41	39.53	32.08	10	3.8
68	1978-05-06	16:35:10	40.6	32.88	10	1
69	1978-07-04	22:39:17	39.45	33.19	23	4.9
70	1978-07-04	23:20:31	39.5	33.3	10	4
71	1978-07-05	23:18:24	39.49	33.2	0	3.9
72	1978-08-14	01:37:58	40.3	33.8	10	4.1
73	1978-10-14	08:37:44	40.33	32.74	0	2.5
74	1978-11-03	09:35:03	40.91	32.35	0	4.2
75	1978-11-24	16:06:00	3.6	32	0	3.7
76	1979-01-22	22:59:57	39.9	33.6	0	3.7
77	1979-01-28	04:36:05	39.9	33.1	0	3.8
78	1979-03-21	17:56:19	38.7	32	0	2.8
79	1979-04-27	02:33:50	40.61	32.88	0	3.9
80	1979-05-29	14:23:09	40.89	33.58	0	4.1
81	1979-08-25	04:29:50	39.57	32.2	0	3.7
82	1979-08-31	15:15:36	40.82	33.73	1	4
83	1979-08-31	15:49:54	40.92	33.8	0	3.3
84	1979-10-18	07:47:13	40.9	33.4	33	3.2
85	1979-10-19	00:13:07	40.98	33.45	10	3.2
86	1980-05-09	12:10:52	38.9	32.6	33	4.3
87	1980-05-18	12:09:24	40	32.9	13	3.7
88	1980-05-27	16:16:26	38.86	32	33	1
89	1980-10-02	11:21:35	40.09	33.17	33	4.1
90	1980-01-02	23:30:30	40.04	33.1	0	3.4
91	1980-10-03	14:00:56	40.21	33.07	0	3.9
92	1980-10-31	21:33:15	39.4	33.16	0	1
93	1981-04-10	03:16:43	39	33.1	38	4
94	1981-05-14	04:37:13	39.23	33.21	10	3.9
95	1981-09-18	05:24:33	40.64	32.8	0	2.6
96	1982-02-17	15:08:50	40.38	33.31	10	4
97	1982-09-09	06:37:42	39.46	32.8	4	1
98	1983-01-21	21:52:29	39.4	32.3	10	4.5
99	1983-02-27	07:39:20	39.51	33.02	8	1

continued →

100	1983-03-21	02:43:08	39.3	33.2	10	1	
101	**1983-04-18**	**01:46:48**	**40**	**33.13**	**10**	**1**	**Kulu (Bala) earthquake; Kalafat, 1998**
102	1983-04-20	13:48:20	40.44	32.51	0	1	
103	1983-04-21	16:18:57	39.31	33.06	36	4.7	
104	1983-04-23	13:40:38	39.4	33.07	9	1	
105	1983-04-27	22:41:05	39.59	32.94	0	1	
106	1983-05-28	02:12:33	40.6	32.67	10	3.8	
107	1993-12-24	04:03:37	39.5	33.2	10	3.5	
108	1984-04-06	02:46:02	39.91	32.31	4	3.1	
109	1984-06-12	13:57:09	38.9	32	0	3.5	
110	1984-06-23	13:31:23	38.9	32	10	4	
11	1984-10-03	02:33:07	39.46	33.68	0	1	
112	1985-03-03	13:02:13	39.13	33.17	10	4.3	
113	1985-04-06	04:42:00	39.55	32.93	5	4.4	
114	1985-05-22	21:53:16	39.6	33.7	10	4	
115	1985-08-12	23:39:24	40.94	33.6	10	1	
116	1985-11-17	00:16:43	40	33.87	33	1	
117	1985-11-23	23:44:48	38.94	32.74	1	2.7	
118	1986-02-24	16:17:07	39	32.3	10	3.1	
119	1986-03-03	21:12:41	40.89	33.5	10	3.8	
120	1986-05-07	03:10:06	40.04	33.15	10	3.7	
121	1986-06-03	10:13:52	40.24	32.4	9	3.7	
122	1986-07-20	05:07:14	39.62	32.7	10	1	
123	1986-07-21	02:06:33	40.33	33.45	10	3.6	
124	1986-11-24	09:18:29	40.5	32.4	10	3.3	
125	1987-02-20	17:59:05	40.46	32.93	10	1	
126	1987-03-01	04:41:47	39	33	33	1	
127	1987-05-09	08:07:42	40.52	32.8	9	3.8	
128	1987-06-01	21:32:31	40.06	32.56	10	3	
129	1987-06-02	10:14:46	38.78	31.7	1	2.9	
130	1987-09-14	05:00:50	39.59	32.16	10	3.7	
131	1988-07-17	23:40:06	38.99	33.84	10	2.7	
132	1988-08-11	04:57:41	40.1	33	10	1	
133	1988-10-08	21:01:18	39.86	33.3	1	1	
134	1988-12-19	20:40:08	38.52	32.37	10	1	
135	1989-03-18	17:29:54	39.69	33.1	33	1	
136	1989-08-29	14:18:10	40.4	33.3	7	4.1	
137	1989-10-14	21:12:03	39.74	32.83	10	4	
138	1989-10-15	16:55:14	40.1	32.8	5	3.5	
139	1990-04-28	19:03:11	40.6	33.2	10	3.4	
140	1990-08-05	18:31:50	40.23	33.88	17	4.8	
141	1990-10-18	23:29:16	40.2	33.88	10	4.2	
142	1991-07-02	13:34:21	38.87	32.7	10	1	
143	1991-07-02	23:38:08	38.86	2.7	10	1	
144	1991-10-02	15:20:27	40.44	33.29	33	4.2	
145	1991-10-17	23:28:22	40.05	32.41	10	1	
146	1991-10-19	28:48:35	39.89	32.38	10	1	
147	1991-11-18	19:48:51	38.9	33.42	10	3.9	
148	1991-12-22	04:24:04	40.88	33.29	44	3.5	
149	1991-12-29	17:24:49	40.36	32.41	10	1	
150	1992-02-14	03:27:41	39.9	33.94	16	4.2	
151	1992-02-23	17:24:36	40.32	33.13	5	3.6	
152	1992-02-27	15:24:09	39.57	32.77	10	1	

continued →

153	1992-03-02	04:50:02	40.33	32.98	10	3.5	
154	1992-03-06	04:17:42	40.21	33.46	10	1	
155	1992-03-06	06:05:17	40.2	33.5	33	3	
156	1992-05-05	08:56:09	39.77	32.78	10	1	
157	1992-05-09	14:31:32	39.84	32.77	10	1	
158	1992-05-11	08:29:41	39.83	32.76	10	1	
159	1992-05-19	23:00:54	40.74	32.48	7	3.6	
160	1992-06-08	17:42:09	39.61	33.13	10	1	
161	1992-06-11	12:35:04	40.21	32.5	10	3.3	
162	1992-06-16	00:42:52	40.23	33.94	10	1	
163	1992-07-01	11:29:09	40.8	32.5	6	1	
164	1992-07-15	02:01:25	40.1	33.4	10	1	
165	1992-07-19	17:15:33	39.8	33.1	10	1	
166	1992-07-23	14:11:24	39.83	32.73	5	1	
167	1992-07-29	14:01:22	39.8	33	10	1	
168	1992-09-11	22:56:34	39.8	33.2	10	3	
169	1992-09-25	14:14:52	40.1	32.6	10	2.7	
170	1992-09-29	14:12:31	39.1	33.4	33	1	
171	1993-01-25	05:17:18	40.67	32.85	10	3.9	
172	1993-02-03	12:00:50	40.87	32.81	5	3.9	
173	1993-04-06	21:39:23	40.52	32.42	10	3.8	
174	1993-05-05	13:40:59	40.98	33.13	10	1	
175	1993-07-30	09:01:56	39.81	32.78	10	2.7	
176	1993-07-30	09:49:36	39.57	32.8	10	2.8	
177	1993-11-03	09:48:34	39.72	32.96	10	1	
178	1993-12-11	05:21:21	38.51	33.45	8	3.3	
179	1993-12-23	09:18:17	39.87	33.07	10	1	
180	1994-01-19	18:35:40	40	33.05	10	3.9	
181	1994-01-24	08:31:05	39.35	33.46	5	3.6	
182	1994-02-26	11:37:53	39.8	33.19	5	3.7	
183	1994-03-11	08:15:26	38.51	33.67	0	3.8	
184	1994-04-24	11:40:32	39.97	33.16	0	3	
185	**1995-04-04**	**11:23:28**	**40.4**	**32.77**	**7**	**4**	**Başbereket earthquake; Baran,1996**
186	1995-04-16	10:04:31	40.64	33.51	18	4	
187	1995-04-16	10:59:21	40.58	33.64	25	3.7	
188	1995-07-25	19:18:43	38.74	32.2	0	3.3	
189	1995-11-10	05:22:36	40.89	32.66	0	3.4	
190	1996-01-08	20:23:57	38.69	32.03	31	3	
191	1996-03-25	01:39:24	38.93	32.4	4	3.9	
192	1996-04-10	02:29:40	40.41	32.25	0	3.5	
193	1996-04-11	01:20:43	39.44	32.32	0	3.2	
194	1996-04-16	14:11:20	39.76	33.49	7	3.4	
195	1996-04-22	22:17:30	40.54	32.78	9	3.6	
196	1996-04-22	02:20:17	40.66	32.78	7	3.4	
197	1996-07-02	06:25:59	40.56	32.68	10	3.5	
198	1996-08-27	14:40:05	38.78	32.54	0	4	
199	1996-12-11	20:12:01	38.65	33.07	5	3.4	
200	1997-04-23	10:29:07	40.84	32.9	0	3.4	
201	1997-06-14	07:47:18	39.92	32.64	7	3.6	
202	1997-06-14	22:42:37	40.76	33.99	8	3.2	
203	1997-09-01	17:10:59	38.86	32.87	4	3.4	
204	1997-09-15	20:11:51	38.83	32.44	0	3.6	
205	1997-10-14	17:03:27	38.77	32.65	13	3.6	
206	1997-12-09	08:02:05	40.56	32.37	0	3.2	

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207	1997-12-15	11:55:44	40.81	32.86	5	3.1
208	1997-12-19	18:06:37	40.76	33.48	5	3.9
209	1998-01-06	18:38:51	40.78	32.72	12	3.5
210	1998-01-06	18:38:51	40.78	32.72	12	3.5
211	1998-01-17	23:54:05	40.6	33.93	14	3.1
212	1998-01-17	23:54:05	40.6	33.93	14	3.1
213	1998-01-25	12:11:37	40.16	32.08	8	3.7
214	1998-01-25	12:11:37	40.16	32.08	8	3.7
215	1998-02-22	04:09:43	40.41	32	0	3.4
216	1998-02-22	04:09:43	40.41	32	0	3.4
217	1998-03-13	16:08:46	40.8	32.15	1	2.8
218	1998-03-13	16:08:46	40.8	32.15	1	2.8
219	1998-03-20	08:48:27	40.43	32.86	10	3.3
220	1998-03-20	08:48:27	40.43	32.86	10	3.3
221	1998-05-01	07:47:04	40.68	33.75	5	3.9
222	1998-05-01	07:47:04	40.68	33.75	5	3.9
223	1998-05-01	07:50:41	40.63	33.82	42	3.3
224	1998-05-01	07:50:41	40.63	33.82	42	3.3
225	1998-07-03	03:47:34	40.82	33.75	5	3.2
226	1998-07-03	03:47:34	40.82	33.75	5	3.2
227	1998-09-07	10:49:40	39.65	33.97	14	3.6
228	1998-09-07	10:49:40	39.65	33.97	14	3.6
229	1998-09-16	15:34:30	39.67	33.14	2	3.3
230	1998-09-16	15:34:30	39.67	33.14	2	3.3
231	1998-10-15	11:48:25	39.42	32.01	0	3.4
232	1998-10-15	11:48:25	39.42	32.01	0	3.4
233	1995-11-05	13:46:46	40.87	32.52	4	3.9
234	1998-11-05	13:46:46	40.87	32.52	4	3.9
235	1998-12-15	15:50:16	38.85	32.92	0	3.8
236	1998-12-15	15:50:16	38.85	32.92	0	3.8
237	1999-01-22	01:25:34	40.03	32.76	7.62	4.3
238	1999-02-06	12:21:51	40.64	32.74	11.92	3.5
239	1999-02-13	21:56:22	40.95	32.97	3.48	3
240	1999-02-14	13:49:10	40.43	33.23	0.83	3.4
241	1999-02-16	08:41:01	40.62	33.12	9.55	3.4
242	1999-02-17	09:25:09	40.99	32.99	9.03	3.6
243	1999-03-07	11:28:59	40.76	33.02	28.92	3.3
244	1999-03-12	04:54:26	40.78	33.03	2.88	3.5
245	1999-03-17	20:27:45	40.26	32.14	5.32	4.1
246	1999-03-17	21:19:02	40.67	31.97	17.83	3.6
247	1999-03-19	08:11:28	39.95	32.08	8.22	3.5
248	1999-03-20	07:01:30	40.47	33.16	2.75	3.4
249	1999-03-22	01:44:51	40.7	33.02	18.66	3.7
250	1999-03-28	09:56:48	40.73	33.08	0.43	3.3
251	1999-03-28	13:53:56	40.61	33.07	1.08	4
252	1999-03-28	22:43:02	40.65	33.16	28.32	3.3
253	1999-04-01	19:55:10	40.61	33.09	31.85	3.5
254	1999-04-01	19:57:51	40.62	33.06	31.85	3.6
255	1999-04-02	02:30:40	40.25	32.18	11.64	3.8
256	1999-04-04	09:39:01	40.54	32.98	2.01	3.3
257	1999-04-05	06:44:46	40.22	33.45	2.1	3.1
258	1999-04-06	02:22:58	40.62	33.02	32.34	3.1
259	1999-04-10	13:11:47	40.56	33.16	31.66	3.2
260	1999-04-16	16:12:56	40.5	33.08	11.35	3.6
261	1999-04-22	10:38:04	40.65	33.11	14.3	3.2

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262	1999-04-23	08:10:30	40.22	33.3	24.74	3.1	
263	1999-04-23	18:07:39	40.57	33.15	0.14	3.1	
264	1999-04-24	02:16:29	40.55	33.16	4.76	3.1	
265	1999-04-27	20:29:03	40.74	33.03	0.07	3.7	
266	1999-04-27	22:37:17	40.63	33.03	0.23	3.6	
267	1999-04-28	07:18:09	40.35	33.26	15.96	3	
268	1999-04-30	16:50:30	40.74	33.04	27.04	3.6	
269	1999-04-30	17:59:49	40.73	33.02	1.86	3.7	
270	1905-06-21	21:11:14	40.78	32.36	0.18	3.4	
271	1999-05-21	09:04:57	40.89	32.91	9.48	3.4	
272	1999-05-22	02:14:38	40.49	33.74	4.93	4.1	
273	1999-05-23	06:53:11	40.53	33.15	25.45	3.4	
274	1999-05-27	17:52:51	40.59	33.1	5.24	3.4	
275	1999-06-08	12:05:06	40.73	33.05	0.05	3.1	
276	1999-06-12	06:27:02	40.46	33.36	20.5	3.1	
277	1999-06-12	06:31:01	40.75	33.16	0.05	3.2	
278	1999-06-15	06:19:33	40.81	33.13	11.99	3.4	
279	1999-06-16	14:50:55	40.94	33.87	1.2	4.1	
280	1999-06-18	12:46:37	40.92	33.92	0.07	3.8	
290	1999-06-19	23:11:45	40.9	33.93	0.04	3.3	
291	1999-06-30	17:39:05	40.08	33.42	8.39	3.2	
292	1999-07-03	00:39:26	40.67	33.05	3.65	3.9	
293	1999-07-04	23:10:48	40.81	32.87	22.72	3.8	
294	1999-07-04	23:20:24	40.75	33.11	0.06	3.2	
295	1999-07-04	23:47:51	40.83	32.99	0.57	3	
296	1999-07-07	10:10:43	40.57	33.1	0.14	3.1	
297	1999-07-07	13:09:39	40.81	32.35	5.59	3	
298	1999-07-07	13:42:05	40.6	33.08	0.25	3.7	
299	1999-07-10	00:45:46	40.65	33.03	0.11	4	
300	1999-07-10	04:18:46	40.61	33.06	7.39	3.5	
301	1999-07-16	16:06:47	40.76	32.89	23.6	3.8	
302	1999-07-18	10:51:45	38.56	33.74	0.04	3.6	
303	1999-08-24	17:33:15	39.61	32.62	8	4.7	
304	1999-08-30	06:51:16	39.31	32.4	2	4.1	
305	1999-09-08	12:20:46	40.73	33.14	5	3.7	
306	1999-10-09	18:30:01	38.69	32.17	1	3.2	
307	1999-10-16	05:00:36	40.61	33.02	5	3.5	
308	1999-11-20	03:37:04	40.07	33.38	13	3.8	
309	1999-11-20	09:35:40	40.95	32.08	3	3	
310	1999-12-15	08:30:07	40.45	33.28	20	3.4	
311	1999-12-19	23:37:20	40.99	33.8	1	4	
312	1999-12-20	00:02:15	40.95	33.85	1	3.8	
313	2000-02-07	19:20:46	40.09	33.91	5	3.7	
314	2000-02-25	18:35:37	40.81	32.95	9	4	
315	2000-02-29	20:43:00	40	33.94	5	4.1	
316	2000-03-28	17:23:00	38.82	32.54	7	3.9	
317	2000-04-08	19:05:41	40.99	33.01	32	3.1	
318	2000-05-12	12:22:54	40.98	33.58	5	3.6	
319	2000-05-14	18:03:18	40.9	32.93	31	3.6	
320	2000-05-27	06:05:45	40.89	33.5	5	3.8	
321	**2000-06-06**	**02:41:51**	**40.72**	**32.87**	**10**	**5.9**	**Orta earthquake, TERI in: Koçyiğit et.al., 2001**
322	2000-06-06	04:24:10	40.86	32.99	5	3.2	

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323	2000-06-06	05:40:07	40.92	32.83	5	3.4	
324	2000-06-06	05:59:41	40.89	32.9	10	4.5	
325	2000-06-06	11:38:55	40.9	32.99	5	3.2	
326	2000-06-06	12:16:20	40.62	32.97	10	3.9	
327	2000-06-07	02:10:44	40.46	33.25	9	3.3	
328	2000-06-08	00:33:12	40.88	32.8	7	3.3	
329	2000-06-08	17:02:11	40.87	33.03	6	3.2	
330	2000-06-08	21:27:57	40.64	33.01	22	5	
331	2000-06-08	23:11:12	40.93	32.84	33	3.1	
332	2000-06-09	00:11:50	40.75	32.89	12	3.2	
333	2000-06-09	03:14:20	40.63	32.97	20	5.2	
334	2000-06-09	06:38:12	40.47	33.12	9	3.6	
335	2000-06-09	11:48:28	40.39	33.02	7	4	
336	2000-06-09	17:00:39	40.98	32.95	5	3.4	
337	2000-06-10	01:10:24	40.8	32.93	5	3.6	
338	2000-06-10	02:29:00	40.87	32.94	5	3.7	
339	2000-06-10	04:49:07	40.4	33.1	3	3.2	
340	2000-06-10	07:58:01	40.66	33.04	10	3.5	
341	2000-06-11	23:31:50	40.77	32.96	5	3.2	
342	2000-06-13	03:49:03	40.87	32.87	32	3.5	
343	2000-06-15	04:16:46	40.47	33.13	13	3.5	
344	2000-06-16	05:25:48	40.85	32.96	6	3.4	
345	2000-06-16	20:56:49	40.88	32.89	5	3.3	
346	2000-06-21	21:34:43	40.93	32.9	5	3.3	
347	2000-06-22	15:03:38	40.82	32.93	5	3.3	
348	2000-06-28	08:00:57	40.51	33.02	5	3.8	
349	2000-06-28	17:50:07	40.92	32.93	5	3.4	
350	2000-07-02	06:50:24	40.47	33.07	8	3.7	
351	2000-07-02	20:30:26	40.47	33.04	5	3.2	
352	2000-07-10	10:08:08	40.74	32.96	1	3	
353	2000-07-11	19:34:49	40.95	32.9	5	3	
354	2000-07-12	20:52:30	40.7	32.95	4	3.2	
355	2000-07-13	15:58:54	40.8	32.94	5	3.1	
356	2000-07-17	02:44:14	40.55	33.14	33	3.3	
357	2000-07-17	06:47:27	40.71	32.94	14	3.4	
358	2000-07-18	06:29:33	40.68	33.01	17	3.2	
359	2000-08-02	14:01:23	40.86	32.92	5	3.2	
360	2000-08-02	16:25:23	40.61	33.08	14	3.2	
361	2000-08-03	14:09:59	40.82	32.91	8	3.5	
362	2000-08-08	08:25:19	40.69	33.05	5	3.4	
363	2000-08-10	11:15:34	40.99	32.88	5	3.2	
364	2000-08-12	06:03:11	40.61	32.93	29	3.5	
465	2000-08-13	19:08:11	40.7	32.95	5	3.4	
466	**2000-08-22**	**11:40:11**	**40.32**	**32.13**	**10**	**4.3**	**Uruş earthquake, This study**
467	2000-08-22	14:42:05	40.19	32.02	7	3.8	
368	2000-08-22	16:31:50	40.32	32.13	10	3.3	
369	2000-08-22	16:54:45	40.32	32.13	10	3.5	
370	2000-08-24	15:05:39	40.35	32.01	10	3.5	
371	2000-08-28	22:27:48	40.63	32.98	17	4.2	
372	2000-08-29	02:06:14	40.62	32.89	6	3.8	
373	2000-09-01	10:31:57	40.7	33.04	13	3.5	
374	2000-09-02	02:53:51	40.67	32.79	8	4	
375	2000-09-02	11:01:04	40.58	32.97	1	3.8	
376	2000-09-10	13:02:39	40.93	32.95	5	3.1	

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377	2000-09-19	11:48:41	40.67	32.98	2	3.6
378	2000-09-27	12:19:37	40.53	33.02	8	4
379	2000-10-04	00:04:32	40.65	32.97	5	3.3
380	2000-10-05	08:34:45	40.54	33.01	5	4.3
381	2000-10-05	08:38:09	40.42	33.1	12	4.1
382	2000-10-10	08:06:42	40.63	33.02	4	2.9
383	2000-10-27	09:34:59	40.56	32.93	6	3.6
384	2000-11-08	23:00:53	40.82	33.04	5	2.7
385	2000-11-26	03:27:36	40.78	33.04	0.17	3.2
386	2000-11-28	05:38:32	40.7	33.08	0.06	3.4
387	2000-11-28	12:57:47	40.58	33.2	0.12	3.1
388	2000-12-02	03:06:40	40.93	33.28	29.61	2.7
389	2000-12-09	23:46:50	40.66	33.03	0.68	2.8
390	2000-12-12	10:20:12	40.66	32.09	0.18	3.2
391	2000-12-23	01:52:59	40.4	32.81	11.08	3
392	2000-12-24	01:08:43	40.6	32.81	5.35	2.8
393	2001-01-01	14:07:10	40.66	32.98	7.35	3
394	2001-01-02	05:10:22	40.74	32.99	0.02	3.1
395	2001-01-03	22:06:38	40.7	33.01	9.54	3.5
396	2001-01-04	03:57:43	40.83	33.27	0.87	2.9
397	2001-01-13	20:02:20	40.36	32.15	0.82	3.1
398	2001-01-14	04:34:09	40.17	32.16	8.81	3.3
399	2001-01-18	00:49:10	40.67	33.05	8.46	3.2
400	2001-02-04	10:07:05	40.66	33.03	14.41	2.8
401	2001-02-25	01:07:22	40.67	32.97	6.18	2.8
402	2001-02-28	21:27:21	40.72	33.02	0.08	3.3
403	2001-03-04	20:52:16	40.37	33.32	9.23	3
404	2001-03-11	19:20:46	38.54	33.79	8.04	4.1
405	2001-03-15	18:38:08	40.75	33.01	4.98	2.5
406	2001-03-15	22:16:50	40.73	33.02	5.22	2.8
407	2001-03-18	03:39:03	40.64	33.08	7.51	2.2
408	2001-03-22	14:02:22	40.67	32.94	5.38	4.3
409	2001-03-26	01:12:56	40.78	33.02	0.08	3.5
410	2001-03-30	01:18:09	40.74	33.09	0.1	1.9
411	2001-03-30	03:48:17	40.67	33.03	19.39	2.4
412	2001-03-30	03:58:07	40.7	33.04	17.46	2.3
413	2001-04-19	17:16:25	40.01	32.44	0.1	2.7
414	2001-04-23	15:45:16	39.96	32.75	2.42	2.9
415	2001-04-23	21:07:59	40.03	32.74	0.79	3
416	2001-04-23	22:05:41	40.06	32.71	0.12	2.9
417	2001-05-06	07:47:20	40.3	33.7	21.02	3.7
418	2001-05-07	21:08:30	40.43	32.87	7.32	2.5
419	2001-05-09	00:41:03	40.67	32.98	6.22	3.1
420	2001-05-11	21:59:18	40.76	32.23	5.36	2.3
421	2001-05-13	09:28:51	40.67	32.97	8.37	3.7
422	2001-05-14	21:13:53	40.79	32.25	7.7	3.1
423	2001-05-14	22:07:45	40.31	33.89	9.53	3.7
424	2001-05-14	23:14:28	40.38	33.93	0.06	3
425	2001-05-15	02:32:06	40.61	33.62	5	2.4
426	2001-05-15	03:18:46	40.34	33.94	7.49	3.5
427	2001-05-15	11:09:04	40.36	33.83	0.09	3.7
428	2001-05-15	15:18:09	40.31	33.75	20.27	2.6
429	2001-05-17	13:06:20	40.36	33.85	9.55	3.3
430	2001-05-18	18:47:29	40.26	33.85	5.87	2.8
431	2001-05-18	22:21:56	40.85	32.23	2.38	2.8

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432	2001-05-20	02:26:00	40.37	33.8	20.16	2.9
433	2001-05-21	19:28:49	40.46	33.74	22.09	2.5
434	2001-05-22	00:13:59	40.35	33.82	18.78	2.3
435	2001-05-23	21:09:07	40.72	33.02	4.04	2.6
436	2001-05-30	07:24:35	40.4	33.82	9.21	3.1
437	2001-05-30	07:43:49	40.35	33.87	11.85	3.2
438	2001-05-30	16:48:57	40.12	33.95	4.31	2.8
439	2001-05-30	16:50:01	40.27	33.91	5.46	2.8
440	2001-06-02	01:42:48	40.59	33.04	1.78	2.7
441	2001-06-03	15:59:04	40.67	32.99	5.41	2.4
442	2001-06-20	14:05:49	40.65	32.95	2.32	3.5
443	2001-06-27	07:38:05	40.37	33.88	0.26	3.5
444	2001-06-30	22:14:00	40.2	33.2	0.56	2.7
445	2001-07-05	02:00:14	40.66	33	5.38	2.1
446	2001-07-08	20:30:36	40.4	33.86	9.87	3.3
447	2001-07-10	08:45:52	40.7	33	7.13	3.6
448	2001-07-12	04:42:00	40.67	33.02	6.35	2.7
449	2001-07-14	18:44:00	40.63	33.07	10.11	3.1
450	2001-07-18	02:53:00	40.39	33.89	5	3.1
451	2001-07-27	01:33:00.0	40.84	33.94	5	2.2
452	2001-08-01	22:36:00	39.65	32.68	5	3.4
453	2001-08-04	18:22:00	40.17	33.21	14.8	2.1
454	2001-08-08	01:27:00	40.66	33.04	5	3.3
455	2001-08-12	18:31:00	40.33	33.74	17.15	4.3
456	2001-08-12	18:38:00	40.3	33.78	10.4	4.1
457	2001-08-12	19:16:00	40.37	33.93	5	3.3
458	2001-08-12	19:43:00	40.33	33.39	29.62	2.7
459	2001-08-13	07:31:00	40.37	33.95	2.62	3.3
460	2001-08-13	20:05:00	40.25	33.55	23.76	2.2
461	2001-08-14	21:01:00	40.36	33.9	5	2.8
462	2001-08-17	22:04:00	40.84	33.15	4.98	2.5
463	2001-08-21	11:11:00	40.32	33.91	7.42	3.3
464	2001-08-24	06:52:00	40.39	33.93	11.49	3.2
465	2001-08-26	02:27:00	40.37	33.94	7.52	3.3
466	2001-08-26	02:41:00	40.3	33.75	21.57	2.5
467	2001-08-26	03:01:00	40.37	33.93	3.27	3.2
468	2001-08-26	06:44:00	40.45	33.35	30.05	2.9
469	2001-08-26	20:53:00	40.4	33.91	5	3.1
470	2001-09-03	14:40:00	39.16	31.99	5	3.1
471	2001-09-05	09:32:00	40.43	33.91	5	2.8
472	2001-09-06	00:30:00	40.41	33.91	5	2.5
473	2001-11-04	20:19:00	40.72	33.27	5	2.5
474	2001-11-15	23:23:00	40.34	33.78	7.62	3.8
475	2001-11-18	17:48:00	40.4	33.89	9.51	2.9
476	2001-11-18	18:44:00	40.4	33.9	8.25	2.7
477	2001-12-03	21:07:00	40.05	33.19	5	2.6
478	2001-12-13	13:15:00	40.94	33.61	5	3.1
479	2001-12-16	17:17:00	40.89	33.05	5	3.2
480	2002-01-20	00:10:00	40.64	32.96	6.8	3.8
481	2002-01-24	10:58:00	38.59	32.18	5.26	3.5
482	2002-01-24	19:44:00	40.66	32.92	5.04	2.4
483	2002-02-02	14:43:00	40.66	32.93	5	2.7
484	2002-02-06	22:49:00	40.55	32.96	5.58	3.1
485	2002-02-14	00:26:00	40.65	33.02	12.95	3.2
486	2002-02-20	20:46:00	40.61	32.98	5.12	2.5

continued →

487	2002-02-27	21:26:00	39.95	33.49	8.43	4.1
488	2002-02-28	07:40:00	40.99	33.51	5	3
489	2002-03-01	02:41:00	40.86	33.9	18.14	2.8
490	2002-03-01	14:33:00	39.92	33.39	5.75	2.5
491	2002-03-01	20:15:00	40.66	32.9	9.19	2.6
492	2002-03-01	20:49:00	40.61	32.82	8.62	2.7
493	2002-03-08	16:39:00	40.76	33.05	18.21	2.7
494	2002-03-08	19:53:00	40.66	32.99	5	2.7
495	2002-03-14	04:02:00	40.24	33.61	5.66	2.4
496	2002-03-23	22:19:00	40.56	32.81	8.76	2.6
497	2002-03-25	06:05:00	40.91	33.67	5	2.2
498	2002-03-25	22:38:00	40.21	33.86	9.9	3
499	2002-03-27	02:01:00	40.24	33.96	5	2.4
500	2002-03-31	04:50:00	40.22	33.86	6.92	2.8
501	2002-03-31	05:42:00	39.69	32.22	5	3.4
502	2002-04-05	00:38:00	40.7	32.96	9.67	4
503	2002-04-05	03:09:00	40.73	32.99	9.32	3.1
504	2002-04-06	12:47:00	40.7	32.97	8.97	2.7
505	2002-04-18	20:35:00	40.35	33.93	5	2.1
506	2002-04-29	12:25:00	40.12	33.25	8.94	3.2
507	2002-04-30	12:09:00	40.25	33.83	8.2	4
508	2002-04-30	13:39:00	40.26	33.89	5.35	2.8
509	2002-05-02	02:31:00	40.71	32.67	6.35	2.9
510	2002-05-05	23:46:00	39.81	33.48	11.77	2.8
511	2002-05-12	18:49:00	39.63	32.52	5	3.1
512	2002-05-13	14:06:00	40.6	32.97	3.93	2.7
513	2002-05-14	04:07:00	40.69	32.99	12.09	2.6
514	2002-05-14	04:08:00	40.62	32.98	9.75	3.4
515	2002-05-29	20:24:00	40.67	33.54	14.37	2.7
516	2002-06-03	18:20:00	40.84	33.41	69.31	2.6
517	2002-06-04	01:14:00	40.58	32.97	8.36	2.9
518	2002-06-06	10:09:00	39.91	33.77	2	2.4
519	2002-06-08	20:37:00	40.7	33.11	27.24	2.5
520	2002-06-09	15:03:00	40.73	32.91	5	4
521	2002-06-12	03:06:00	39.71	33.3	8.22	2.9
522	2002-06-12	19:26:00	40.81	32.98	4.96	3.4
523	2002-06-13	13:38:00	40.48	33.03	5	3.2
524	2002-06-14	23:50:00	40.5	32.93	2.16	2.8
525	2002-06-16	07:13:00	38.5	32.94	19.15	3.5
526	2002-06-16	16:05:00	40.66	32.98	8.61	2.8
527	2002-06-18	04:22:00	40.38	33.89	5	3
528	2002-06-22	23:54:00	40.57	33.11	25.22	3.1
529	2002-06-23	13:58:00	40.53	32.92	11.69	2.7
530	2002-06-29	02:11:00	40.61	32.96	13.06	2.7
531	2002-06-29	12:03:00	40.6	32.99	17.84	2.6
532	2002-07-03	10:53:00	39.87	33.44	5	3.1
533	2002-07-07	05:40:00	40.31	32.35	5	3.5
534	2002-07-09	05:35:00	40.58	32.96	6.62	3.2
535	2002-07-12	00:34:00	40.62	32.94	6.43	3.1
536	2002-07-16	01:58:00	39.82	33.45	5.87	2.7
537	2002-07-18	13:37:00	38.74	33.82	31.68	3.4
538	2002-07-19	10:33:00	39.8	33.43	5	2.8
539	2002-07-19	23:42:00	39.73	33.25	10.84	3
540	2002-07-23	09:57:00	40.9	32.96	5	3.1
541	2002-07-23	20:06:00	40.95	32.63	5.19	4.3

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542	2002-07-24	14:50:00	39.94	33.3	3.36	2.9
543	2002-07-27	17:09:00	40.54	33.06	5.95	2.2
544	2002-07-30	20:21:00	40.16	33.88	5	2.6
545	2002-08-11	08:04:00	40.65	32.98	9.81	3.5
546	2002-08-22	00:53:20.1	40.57	33	4.6	2.4
547	2002-08-24	09:12:28.1	40.03	33.53	1	3
548	2002-08-29	05:12:34.7	40.66	32.97	1.6	3.1
549	2002-09-08	02:04:58.5	40.04	32.11	16.6	2.6
550	2002-09-08	10:47:04.4	40.45	32.98	12.4	2.1
551	2002-09-10	10:46:46.6	40.55	32.95	2	2.7
552	2002-09-10	15:01:00.1	40.81	33.05	5.7	2.7
553	2002-09-12	20:52:05.7	40.99	33.41	4.2	2.6
554	2002-09-21	03:55:45.5	39.76	33.14	14	3.7
555	2002-09-21	05:35:29.9	40.58	32.99	13.6	2.6
556	2002-09-28	08:26:39.1	40.53	33	5.6	2.2
557	2002-10-07	02:50:02.5	39.61	32.36	2.5	3.3
558	2002-10-07	04:59:19.9	39.56	32.38	4	3.1
559	2002-10-08	16:57:36.1	40.31	33.57	5.6	3.1
560	2002-10-11	10:49:12.3	40.19	33.42	3.1	2.8
561	2002-10-16	10:16:26.2	40.66	32.99	1	3
562	2002-10-16	10:23:05.6	40.64	32.98	1	2.4
563	2002-10-16	15:42:09.2	39.82	33.01	1.4	2.4
564	2002-10-17	07:27:35.1	40.68	33.01	1.2	2.5
565	2002-10-17	10:33:39.4	39.41	32.09	7	2.9
566	2002-10-18	10:17:12.3	39.96	33.49	1	3
567	2002-10-18	11:08:25.4	40.6	33	5	2.8
568	2002-10-22	09:25:10.0	40.69	32.94	1.2	3.4
569	2002-10-22	15:15:28.9	40.64	32.97	3	2.9
570	2002-10-29	16:24:12.4	39.45	32.94	7.1	3.4
571	2002-10-31	07:46:49.6	40.52	32.94	6	3
572	2002-10-31	13:11:27.7	39.45	32.89	6.4	3.3
573	2002-11-04	07:55:58.1	40.62	32.95	5	2.6
574	2002-11-08	15:15:31.7	40.18	33.37	4.5	2.5
575	2002-11-18	21:38:35.0	40.68	32.89	3.2	2.5
576	2002-11-25	13:45:44.5	39.75	33.16	1	2.8
577	2002-11-27	02:06:04.3	40.21	32.15	4.3	3.5
578	2002-11-27	07:40:58.4	40.02	33.8	10	3.4
579	2002-11-27	20:25:37.9	40.24	32.12	5.6	2.8
580	2002-12-05	12:34:53.8	40.48	32.94	6.6	2.6
581	2002-12-07	10:42:42.2	39.47	32.92	4.9	3.2
582	2002-12-07	12:04:39.1	39.4	33.05	5.6	2.6
583	2002-12-10	18:00:57.5	40.23	32.51	7.8	3.2
584	2002-12-10	19:07:39.3	40.09	32.63	5.2	2.7
585	2002-12-13	13:53:46.3	40.52	32.79	3.8	3.1
586	2002-12-13	20:29:55.5	40.6	33.07	6	3.2
587	2002-12-14	19:16:10.3	39.37	32.92	5.2	2.8
588	2003-01-02	00:08:04.8	40.61	33.11	6	2.4
589	2003-01-04	06:48:23.7	40.62	33.02	18.4	2.7
590	2003-01-04	20:21:45.3	40.62	33.13	3.7	2.6
591	2003-01-09	04:59:11.7	39.01	32.3	6.6	3.5
592	2003-01-10	08:39:44.4	40.62	33.02	5.8	3
593	2003-01-11	20:32:35.1	40.6	33	12.4	2.2
594	2003-01-13	08:56:26.4	40.64	32.98	5.3	2.8
595	2003-01-13	13:34:10.0	40.68	33.36	1	2.5
596	2003-01-14	20:11:22.6	40.46	33	5.1	2.5

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597	2003-01-18	23:15:34.5	40.74	32.99	6.1	2.6	
598	2003-01-23	01:01:59.6	40.55	32.92	1	2.3	
599	2003-01-23	01:01:59.8	40.55	32.96	3	2.6	
600	2003-01-23	08:46:28.6	38.93	32.32	5	2.8	
601	2003-01-23	11:47:14.0	40.63	33.04	3	2.3	
602	2003-01-27	12:48:32.7	40.59	33.79	3.4	3	
603	2003-01-28	08:28:32.1	40.7	32.97	5.8	3.3	
604	2003-01-31	14:59:49.3	40.64	32.95	3.7	3.7	
605	2003-02-03	06:43:17.5	40.63	33.07	9.3	3.1	
606	2003-02-13	03:05:11.3	40.46	33.04	6.5	3.6	
607	2003-02-14	03:31:40.7	40.57	33.02	4.5	3.6	
608	**2003-02-27**	**18:36:58.9**	**40.43**	**32.52**	**2.1**	**3.8**	**Çamlıdere earthquake, this study**
609	2003-02-27	19:00:50.6	40.41	32.55	2	3.2	
610	2003-02-27	20:47:53.1	40.39	32.5	3.8	2.9	
611	2003-02-27	21:08:15.3	40.31	32.61	7	2.4	
612	2003-02-27	21:41:46.4	40.36	32.48	6	2.7	
613	2003-02-28	22:35:24.6	40.38	32.57	3	2.9	
614	2003-03-02	16:26:16.1	40.37	32.52	6.6	2.8	
615	2003-03-03	00:38:39.6	40.39	32.53	5.9	2.8	
616	2003-03-09	19:42:41.4	40.5	33.05	6.6	2.6	
617	2003-03-11	22:51:42.5	40.32	32.48	6.7	2.7	
618	2003-03-12	02:24:39.3	40.7	33.98	1.2	3.1	
619	2003-03-12	02:32:50.3	40.54	33.05	9.2	3.7	
620	2003-03-18	13:15:10.1	40.6	32.99	13	2.5	
621	2003-03-25	06:35:31.2	40.44	33.29	4.6	2.7	
622	2003-03-27	05:29:36.1	40.29	33.44	4.3	2.8	
623	2003-04-02	05:34:51.6	40.38	32.51	1.9	3.1	
624	2003-04-10	17:47:39.1	40.61	33.01	3.8	3.7	
625	2003-04-10	19:19:36.2	40.68	33.11	4.1	2.9	
626	2003-04-10	19:55:21.5	40.6	33	6.7	3.5	
627	2003-04-10	21:06:44.1	40.58	33.04	11.2	2.2	
628	2003-04-10	22:25:24.2	40.62	33.07	5.9	2.2	
629	2003-04-11	05:53:42.5	40.6	33.01	2.3	2.5	
630	2003-04-11	07:20:36.0	40.63	33.01	7.3	2.3	
631	2003-04-11	13:17:51.1	40.62	33.02	1.9	3	
632	2003-04-12	00:17:09.4	40.6	33	1	2.5	
633	2003-04-22	06:27:43.9	40.69	32.96	1	2.7	
634	2003-04-23	09:37:26.7	39.97	33.03	1	2.3	
635	2003-05-16	21:46:05.4	40.44	33.01	18	2.5	
636	2003-05-19	16:12:43.6	40.57	33.06	1.2	2.9	
637	2003-05-22	05:46:52.3	40.6	33.02	2.5	3.4	
638	2003-05-23	14:59:27.3	40.59	33.01	8	3.5	
639	2003-05-26	16:51:45.0	40.68	33.95	2	3.2	
640	2003-05-27	01:06:44.8	40.52	33.5	4	2.9	
641	2003-06-09	17:19:39.7	39.37	32.81	5.7	2.9	
642	2003-06-16	17:03:09.0	40.58	33	2.8	2.9	
643	2003-06-25	23:18:14.8	40.68	33.48	1	2.7	
644	2003-07-04	10:42:36.2	40.68	33.01	5.6	3.2	
645	2003-07-11	14:57:43.4	39.66	32.75	5.9	2.8	
646	2003-07-16	11:15:29.8	40.74	32.99	4.6	3.4	
647	2003-07-17	13:40:45.5	40.04	33.54	5.8	2.9	
648	2003-08-03	14:17:52.3	39.98	32.88	8.6	2.9	
649	2003-08-12	12:18:53.4	40.61	33.12	15	2.9	
650	2003-08-20	05:46:38.4	40.61	33	1	2.8	

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651	2003-08-21	12:21:27.8	40.38	33.04	11.6	2.3
652	2003-08-26	04:44:10.3	40.6	32.99	2.2	2.9
653	2003-08-26	05:06:41.0	40.62	32.97	2.4	3
654	2003-08-26	05:20:21.0	40.67	32.93	4.2	2.7
655	2003-08-31	09:50:42.7	40.39	32.94	2.6	3.4
656	2003-08-31	22:07:17.5	40.41	32.91	3.8	3.6
657	2003-09-01	16:43:11.1	40.88	32.47	1	3.8
658	2003-09-07	02:36:42.7	40.66	33	4.5	3.2
659	2003-09-15	21:00:22.6	39.97	33.97	10.5	2.6
660	2003-09-16	15:29:42.0	40.21	33.23	4.9	2.6
661	2003-09-16	15:29:42.0	40.26	33.16	10.8	2.6
662	2003-09-16	17:24:23.8	39.6	32.9	17.4	3.6
663	2003-09-17	06:57:44.8	39.6	32.95	4.1	3
664	2003-09-17	14:47:11.9	40.48	32.91	1	3
665	2003-09-17	15:18:45.3	40.42	33.04	2.4	3
666	2003-09-22	16:13:20.0	39.55	33.45	10.8	2.7
667	2003-09-23	18:33:18.0	39.69	32.85	7.8	2.7
668	2003-09-27	13:36:30.0	40.56	32.99	3.6	3.1
669	2003-10-03	13:49:10.4	40.01	32.51	10	2.8
670	2003-10-04	12:09:34.8	39.33	33.56	5.4	2.5
671	2003-10-10	04:43:57.5	40.46	33.08	1.2	3
672	2003-10-10	18:14:03.9	40.45	32.82	12.5	3
673	2003-10-16	23:55:30.5	39.8	32.46	1.9	3
674	2003-10-23	02:45:05.2	39.47	33.35	10.5	3.3
675	2003-10-31	12:16:26.0	39.57	33.56	5	2.9
676	2003-11-06	13:33:06.4	40.95	33.49	4.2	2.8
677	2003-11-15	15:54:50.0	40.51	33.97	4.6	2.7
678	2003-11-16	11:04:23.1	39.73	33.16	1	3
679	2003-11-19	12:05:18.6	39.71	33.78	17	2.8
680	2003-11-24	02:41:16.9	39.65	32.43	5.7	2.8
681	2003-11-24	13:07:23.0	40.67	32.98	4.5	3.3
682	2003-11-25	03:47:40.4	40.62	33.02	11.5	3.2
683	2003-11-26	08:25:02.3	40.69	33.01	5.2	2.7
684	2003-11-27	10:25:02.5	39.82	33.1	1	2.6
685	2003-11-29	12:45:27.1	40.01	33.02	11	2.6
686	2003-11-30	12:32:41.4	40.02	32.35	6.8	2.6
687	2003-12-03	11:58:11.6	40.77	33.6	9.2	2.6
688	2003-12-03	13:24:25.2	39.89	32.78	1	3.1
689	2003-12-04	22:50:59.6	39.8	33.21	1.3	3.7
690	2003-12-05	00:00:25.6	39.81	33.18	4.3	3.2
691	2003-12-05	13:44:30.5	39.88	33.18	9.2	3.3
692	2003-12-06	01:03:38.9	40.63	33.03	2.9	2.9
693	2003-12-09	01:50:23.9	40.19	33.65	7	3.2
694	2003-12-09	14:45:34.0	39.81	33.1	1.1	2.8
695	2003-12-10	16:54:51.6	39.71	33.51	10.8	2.9
696	2003-12-11	13:45:36.0	40.93	33.73	5	3
697	2003-12-20	00:08:37.0	41	33.75	13.3	2.7
698	2003-12-22	13:03:02.9	40.51	33.02	1.7	2.8
699	2003-12-23	22:34:13.3	40.65	32.22	7.5	2.6
700	2003-12-25	02:30:10.7	40.43	33.03	4.9	2.7
701	2003-12-29	01:20:45.5	40.63	32.85	3	2.7
702	2003-12-29	01:31:25.8	40.61	32.68	15	2.8
703	2004-01-01	19:28:28.8	40.94	32.78	10	3.1
704	2004-01-02	00:08:04.8	40.61	33.11	6	2.4
705	2004-01-09	15:05:02.8	40.61	32.87	1	2.5

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706	2004-01-09	15:07:02.0	40.65	32.97	4	3.7
707	2004-01-10	01:34:29.3	38.88	32.53	10.6	2.7
708	2004-01-10	01:46:17.0	38.75	32.46	6.2	2.8
709	2004-01-12	10:09:52.0	39.16	31.96	7.8	3
710	2004-01-13	13:34:10.0	40.68	33.36	1	2.5
711	2004-01-18	05:49:07.8	40.96	33.19	1	2.9
712	2004-01-19	09:41:34.3	39.74	33.54	9.5	2.7
713	2004-01-20	16:51:52.1	39.36	32.98	1	3
714	2004-01-21	20:41:02.3	40.62	32.87	3.9	2.8
715	2004-01-21	22:56:04.4	40.35	33.62	6.9	2.8
716	2004-01-23	15:24:19.3	40.7	32.97	5.4	2.5
717	2004-01-28	04:01:45.0	39.8211	33.2588	8.9	3.2
718	2004-01-31	11:21:39.3	40.5915	33.2155	3.1	3
719	2004-01-31	12:09:19.4	40.6344	33.0259	2.6	3.4
720	2004-02-02	12:42:00.1	39.3893	32.8531	9.3	3.2
721	2004-02-07	19:26:21.0	39.2393	32.6033	8	4.1
722	2004-02-08	00:53:30.1	39.4152	32.467	1	2.7
723	2004-02-08	01:26:50.7	39.1672	32.4394	12.3	3.5
724	2004-02-08	09:27:54.6	39.1785	32.4336	5.7	4.4
725	2004-02-08	11:02:06.4	39.2436	32.3986	12.8	2.7
726	2004-02-08	17:36:53.7	39.2453	32.4257	19.3	3.1
727	2004-02-08	22:47:04.1	39.3137	32.3163	11	2.8
728	2004-02-09	10:36:07.2	40.2766	33.286	9	2.9
729	2004-02-11	20:23:55.7	40.6709	32.9917	4.3	2.7
730	2004-02-12	04:22:04.5	39.3646	32.6675	8.7	3.3
731	2004-02-18	10:31:46.6	40.1428	32.1089	21.2	2.8
732	2004-02-18	15:56:44.2	38.8292	33.3611	10.9	3.3
733	2004-02-19	09:52:57.3	40.8109	33.8753	4	2.8
734	2004-02-24	15:25:16.0	40.4413	33.4907	1.5	3.4
735	2004-02-25	02:58:55.9	40.4461	33.4579	1.7	2.7
736	2004-02-26	11:29:18.8	40.5823	32.8579	1	2.4
737	2004-03-02	23:53:16.7	39.4503	32.47	19.5	3.1
738	2004-03-03	11:25:35.1	39.4212	32.9432	1.7	3.6
739	2004-03-03	18:30:26.4	39.149	32.3425	8	2.7
740	2004-03-06	17:15:06.4	40.5898	33.025	2.3	3
741	2004-03-09	16:26:55.6	40.582	33.5006	9	2.4
742	2004-03-11	10:55:27.2	39.8064	32.984	2.9	2.8
743	2004-03-12	02:06:37.7	40.4707	33.5102	1	3.3
744	2004-03-12	02:51:49.8	39.7577	32.7109	2.8	3.3
745	2004-03-12	03:07:49.0	39.73	32.74	3.5	3.2
746	2004-03-16	02:42:20.1	40.5758	32.955	1.8	2.8
747	2004-03-16	03:30:32.8	40.5825	32.8548	2.5	2.8
748	2004-03-16	15:50:46.0	39.9707	32.8905	3.9	2.7
749	2004-03-16	19:22:49.8	39.5517	32.9741	1.3	2.9
750	2004-03-19	22:11:20.9	39.1494	32.4027	11	3.2
751	2004-03-20	03:01:16.6	40.6838	33.058	1.6	3.2
752	2004-03-20	14:36:56.4	40.0034	33.4644	8.9	2.8
753	2004-03-21	18:42:53.8	40.4791	32.9253	12	2.9
754	2004-03-23	21:37:12.3	40.6763	33.1138	8.9	2.7
755	2004-03-24	02:20:45.9	40.6842	33.0078	1.7	3.1
756	2004-03-24	03:12:15.8	40.6069	32.8701	4.4	3
757	2004-03-25	14:59:56.2	39.7702	33.3141	11.1	2.8
758	2004-03-25	15:41:18.3	40.4769	32.8258	2.8	2.7
759	2004-03-28	15:20:09.0	40.3969	32.5295	1	3.1
760	2004-03-28	21:57:12.1	40.6245	32.8872	6.3	2.7

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761	2004-03-30	14:55:51.2	39.87	33.14	7.4	2.9
762	2004-03-31	09:05:17.6	39.8857	33.0129	4.4	2.7
763	2004-04-05	14:25:40.2	40.0096	33.6136	2.2	2.5
764	2004-04-05	18:00:23.6	40.2652	32.5553	3.1	2.8
765	2004-04-09	03:52:28.6	38.7031	32.7976	11	3
766	2004-04-09	08:04:33.3	40.7704	33.0194	10.7	2.8
767	2004-04-09	13:22:34.7	40.2679	33.9477	13.4	2.5
768	2004-04-09	20:01:53.0	40.4203	33.4443	1	2.4
769	2004-04-09	21:05:30.6	39.7859	33.1069	1	2.4
770	2004-04-12	09:23:16.0	39.9441	32.6308	1	2.8
771	2004-04-17	03:15:26.8	40.2082	33.2504	16.1	3.2
772	2004-04-17	17:30:07.5	39.8994	32.9429	14.2	2.7
773	2004-04-18	06:30:37.0	40.678	33.0469	3	3.1
774	2004-04-18	08:08:38.9	40.6918	33.1572	16.8	2.7
775	2004-04-18	12:35:49.7	40.6326	32.9633	11.2	3.1
776	2004-04-20	17:36:33.3	39.6188	33.0967	11.1	2.8
777	2004-04-21	02:40:26.6	40.6861	32.984	1	2.9
778	2004-04-21	09:37:24.9	40.1058	33.6014	10.6	2.5
779	2004-04-21	10:27:46.6	39.7858	33.0037	4.3	3
780	2004-04-26	03:23:50.8	38.8732	33.704	3	2.6
781	2004-04-26	16:42:49.0	39.68	32.6919	1.4	2.3
782	2004-04-27	05:49:38.4	39.8067	33.199	10.5	2.6
783	2004-04-27	12:55:24.7	39.9823	33.4757	3	2.7
784	2004-04-27	13:43:37.6	40.043	32.6091	8.7	2.7
785	2004-04-28	18:15:02.9	40.7166	33.0572	1.4	3.2
786	2004-04-30	14:20:25.9	38.9389	33.5787	12	2.7
787	2004-04-30	15:30:44.6	39.8784	32.9708	2	2.8
788	2004-05-01	10:48:21.6	39.1976	31.998	10.4	3
789	2004-05-02	15:07:15.5	39.9347	33.318	2	2.8
790	2004-05-03	14:36:06.9	40.2331	33.4621	7.2	2.7
791	2004-05-04	15:26:57.5	39.7368	33.1272	1	2
792	2004-05-05	06:34:11.6	40.6897	33.2345	3.7	2.7
793	2004-05-06	10:44:54.0	40.2841	32.6547	5.1	2.2
794	2004-05-06	13:23:47.9	39.764	32.8085	8.2	2.8
795	2004-05-06	14:28:28.6	39.0458	33.8686	10.8	2.9
796	2004-05-10	12:32:54.8	39.9985	33.3705	12.7	2.6
797	2004-05-14	12:19:47.0	39.8293	33.5476	8.9	2.6
798	2004-05-17	10:41:41.1	40.9862	33.399	4.6	3
799	2004-05-19	03:03:46.1	39.8605	33.1819	11.9	3.2
800	2004-05-20	11:13:51.2	39.2723	33.9577	10.6	2.9
801	2004-05-20	14:08:10.1	39.725	32.2682	8.6	2.9
802	2004-05-22	13:54:19.1	39.6078	33.6622	4.2	2.9
803	2004-05-24	02:23:57.7	38.8324	33.2712	2.5	3.3
804	2004-05-24	14:23:53.3	40.6148	33.0861	5.6	3.5
805	2004-05-26	04:53:14.7	39.1818	33.5027	10.6	2.9
806	2004-05-27	09:43:23.2	39.8401	32.8825	1	2.5
807	2004-05-28	10:49:20.9	39.6767	31.9665	5.3	3
808	2004-05-29	06:47:55.4	39.8728	33.1336	2	2.9
809	2004-05-29	15:15:20.5	39.6522	33.0842	8.3	2.5
810	2004-05-30	08:52:07.2	39.8603	33.0004	1.5	2.9
811	2004-05-30	21:57:46.8	39.9261	32.8262	1	2.7
812	2004-06-02	09:50:24.0	39.9098	33.1862	1.7	2.5
813	2004-06-03	06:52:18.6	39.4811	32.9818	8.9	2.5
814	2004-06-03	07:04:18.9	39.9887	32.8617	4.3	2.4
815	2004-06-03	12:57:04.4	39.9025	33.1013	14.2	3

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816	2004-06-03	14:13:18.9	39.5986	33.6294	1	2.8
817	2004-06-04	13:39:23.9	39.9868	33.4813	1.9	2.7
818	2004-06-05	15:02:05.1	40.6371	32.9212	1	2.8
819	2004-06-06	06:58:24.8	39.9565	33.0019	9.2	2.7
820	2004-06-10	08:58:59.4	41	33.4179	8.6	3.7
821	2004-06-11	11:31:11.7	39.7647	32.9955	2.4	2.6
822	2004-06-11	21:57:25.2	40.2165	33.9787	17.6	2.9
823	2004-06-12	17:02:14.4	39.4676	32.7705	14.3	2.4
824	2004-06-14	18:34:51.4	39.7783	32.7921	2.6	2.5
825	2004-06-15	16:02:02.6	39.627	32.0501	8.6	2.7
826	2004-06-16	09:15:16.9	40.9409	32.6378	10.1	2.7
827	2004-06-16	10:32:58.2	39.9388	33.2651	2.2	2.6
828	2004-06-16	12:53:17.7	39.7453	32.9792	1.6	2.5
829	2004-06-16	14:47:06.4	40.015	32.61	4.5	2.9
830	2004-06-17	10:37:06.3	39.7987	33.2947	2.6	2.5
831	2004-06-17	15:04:54.8	39.7113	33.0975	1.9	2.5
832	2004-06-17	15:54:10.9	39.6269	33.6169	4.1	3.1
833	2004-06-21	11:53:33.5	40.8369	32.8505	17	2.9
834	2004-06-21	15:02:17.0	39.5208	33.1806	6.2	2.1
835	2004-06-21	15:08:21.2	39.6345	33.2268	2.6	2.1
836	2004-06-21	15:12:09.3	39.6202	33.2246	10.8	1.7
837	2004-06-22	12:37:04.5	39.6232	32.4396	6.5	2.7
838	2004-06-22	14:03:20.3	39.4065	32.8656	16.4	2.7
839	2004-06-22	16:19:11.1	40.41	33.2101	1.8	3
840	2004-06-22	21:29:09.8	40.7779	33.1469	14.1	2
841	2004-06-25	12:04:47.2	40.9542	32.6185	9.9	2.6
842	2004-06-25	16:12:22.5	40.13	33.81	5	2.8
843	2004-06-28	12:56:11.4	39.6493	32.7654	14.5	2.7
844	2004-06-28	15:11:36.2	39.674	33.1911	4.1	2.4
845	2004-06-29	12:39:24.9	39.9027	33.0351	3.4	3.1
846	2004-06-29	15:38:34.6	39.8819	33.0431	1	2.6
847	2004-07-01	14:43:12.1	39.6208	33.6967	2.9	2.8
848	2004-07-01	15:02:59.5	39.8506	33.0749	2.8	2.5
849	2004-07-01	15:15:07.8	39.6782	32.2094	2.9	2.3
850	2004-07-01	18:08:19.2	40.4817	33.0443	11.7	2.9
851	2004-07-03	15:01:17.0	40.9722	32.5938	16.7	2.6
852	2004-07-03	16:25:30.1	39.7094	32.7096	1	2.6
853	2004-07-03	16:58:03.8	39.7724	32.6941	2.8	2.5
854	2004-07-03	18:00:30.9	40.1096	32.7881	1.8	2.7
855	2004-07-04	21:20:19.9	40.6244	32.9432	8.3	2.9
856	2004-07-05	05:08:09.7	38.9882	32.2505	18.6	3.2
857	2004-07-05	13:20:43.7	39.7366	32.9519	2.1	2.6
858	2004-07-05	15:00:35.8	39.6603	33.0819	1.9	2.5
859	2004-07-05	15:37:58.6	39.6591	33.2217	5.3	2.3
860	2004-07-07	09:53:23.4	39.9733	33.5293	2.5	3
861	2004-07-07	12:16:35.5	39.8075	32.9377	12.5	2.7
862	2004-07-07	15:05:42.0	39.651	33.2434	2.7	2.4
863	2004-07-08	13:55:58.7	39.8467	32.7213	1.7	2.8