Seismicity of Turkey and neighbouring regions, 1899-1915

N. N. AMBRASEYS, C. F. FINKEL

Department of Civil Engineering, Imperial College of Science and Technology, London SW7 2BU, UK

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ABSTRACT. This paper presents in some detail the method used to assess the seismicity of Turkey and neighbouring regions of the eastern Mediterranean during the period 1899-1915 by combining early instrumental data and macroseismic information. This early period is chosen for study because it is poorly-known, because it is the earliest for which instrumental data are available but rarely used, and also because press reports for the period are more abundant than those of later years in information that may be used to supplement other seismological data. More than 750 events were found for the region, thus increasing the number of known earthquakes by a factor of seven : the resulting catalogue forms part of the paper. Magnitudes have been calculated for over 150 events, both on early Milne seismographs and later damped instruments. An empirical relationship that predicts M_s in terms of felt radius and intensity has been established : this allowed assignment of magnitudes from felt effects to another 230 events. It is shown that the instrumental data of the first quarter of this century are invaluable in seismicity studies and that early teleseismic information deserves wider use. It is also shown that the short period sample of 1899-1915 is representative of the regional activity which can be deduced from a longer period of observations and that it represents a background activity independent of the large-scale tectonic elements. It is found that other regions, removed from the Anatolian fault zone, are capable of producing earthquakes of magnitude in excess of 7.0, and that the present-day quiescence of the east Anatolian fault zone is only temporary.

Key words : Turkey, eastern Mediterranean, seismicity, magnitude determination, historical studies.

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INTRODUCTION

The purpose of this paper is to present in some detail the method used to assess the seismicity of the northeast Mediterranean region during the years 1899-1915 by combining early instrumental data and macroseismic information derived from a variety of sources. The resulting catalogue of earthquakes for this period is presented in table 2.

The period 1899-1915 was chosen for study for a number of reasons. First of all, it is a period which is very poorly-known from both the instrumental and macroseismic point of view ; secondly, it is the earliest period for which instrumental data are available, and thirdly, press reports for the period are more abundant than those of later years in information that may be used to supplement other seismological data.

DATA AND METHOD OF ANALYSIS

In preparing this survey of the seismicity of Turkey and neighbouring regions (34° N to 42° N and 26° E to 44° E) (fig. 1) between 1899 and 1915, we have made it a priority to rely as much as possible on primary sources in which the macroseismic and instrumental data are treated in their regional context. At the outset of the survey, we began with a number of earthquake catalogues covering the period (Sieberg, 1932*a*, *b* ; Pinar and Lahn, 1952 ; Ergin *et al.*, 1967 ; Öcal, 1968 ; Kárník, 1968, 1971) : it quickly became clear that such secondary works as are available have many shortcomings and lack the rigorous approach necessary to clarify the true seismicity pattern of the region. By taking them as our starting-point, however, we intended to improve on them by removing errors and misinterpretations.

For each earthquake listed in these catalogues we prepared a worksheet, and to each worksheet transferred all pertinent data and references cited. It at once became obvious that the basic information in Ergin *et al.* (1967) and Kárník (1968) is drawn from Öcal (1968) which, in turn, borrows from Sieberg (1932*a*, *b*) and Pinar and Lahn (1952) among others. However, there is no easy way of checking the information in Öcal (1968), Sieberg (1932*a*, *b*) and

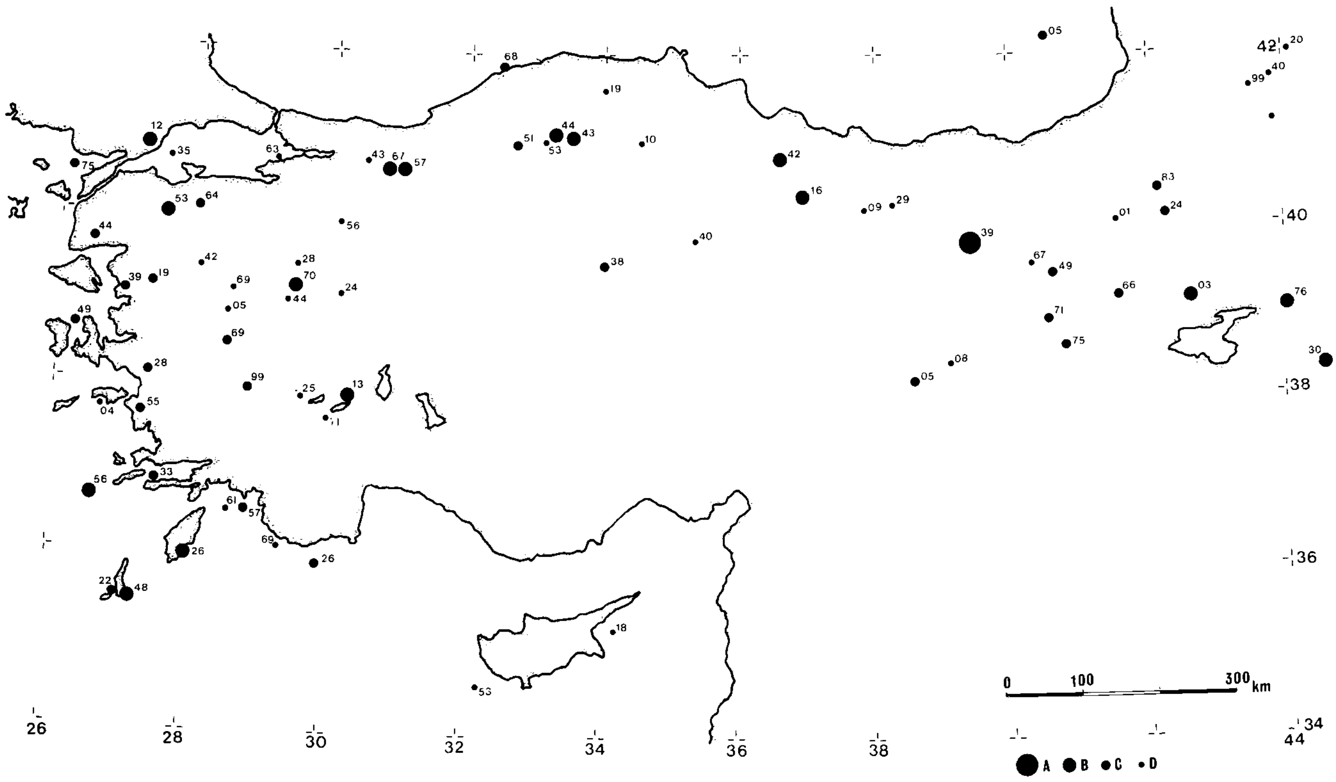

Figure 1
Map of the northeast Mediterranean region under study (34° N *to* 42° N *and* 26° E *to* 44° E), *i.e. Turkey, Cyprus, northern Syria, Lebanon, Iraq, frontiers of Iran and the USSR. The map shows the location of the larger earthquakes* ($M_s \geq 6$) *of the period* 1899-1983. *Numbers refer to the last two figures of the year in which a particular earthquake occurred.* A *implies* $8.0 > M_s \geq 7.5$; B : $7.5 > M_s \geq 7.0$; C : $7.0 > M_s \geq 6.5$; D : $6.5 > M_s \geq 6.0$.

Pinar and Lahn (1952) since these authors do not, in general, give their sources.

As Öcal (1968) explains in his introduction, his survey is based on various materials which he had to hand, as well as on material which he retrieved while at the Geophysical Institute in Jena : the latter comprises data from seismographic stations in particular. Although Öcal indicates the source of his information for each event by means of a number which refers to an item in his bibliography, this bibliography was omitted when his catalogue was published and it is therefore impossible to ascertain his sources or to check the entries in his catalogue.

The situation is little better in the case of Pinar and Lahn (1952). Here, sources of information are various, and include oral information collected from site visits, information obtained from the records of the Ministry of Public Works in Ankara (Bayindirlik Bakanliği), French- and Turkish-language newspapers published in Istanbul, and a number of foreign and Turkish books and catalogues. In Pinar and Lahn's listing of each event, the source of information is given only in the most general terms, depending upon which of these broad groups it falls into, and so, again, it has not been possible to check the accuracy of the catalogue entries.

Sieberg (1932*a*, *b*) gives no indication as to the sources of his information, which similarly prevents further checking.

In order to resolve the ambiguities arising from comparison of existing catalogues, and to improve the regional cover for earthquakes during the period of interest, additional data were transferred to the worksheets for individual events.

First of all, information from the Reports of the British Association for the Advancement of Science (BAAS) and the Shide Circulars, the forerunner of the International Seismological Summary (ISS), were assessed in this way. These early instrumental locations were based on observations reported mainly from undamped seismographs, often with uncertain timing, and in a period when knowledge of seismic velocities and travel times was very poor : these factors often resulted in epicentral locations with gross errors, which need correction. In fact, the only relatively reliable epicentral locations in BAAS are those which have been adopted without calculation, on the evidence of damage observations (Milne, 1909, 1911*b*, 1912, 1913).

A comparison of common events in Öcal (1968) and BAAS shows that the former has included in his catalogue nearly all early instrumental determinations listed by BAAS, to which he then added the name of the town nearest to the epicentre. This form of presentation gives the false impression that the epicentre of the event had been assessed from macroseismic observation, which is not true in most cases.

Secondly, data from Fitzner (1903), Milne (1911*a*), Ballore (1906, 1924) and Gutenberg and Richter (1965) were transferred to the worksheets : this showed them to have been a source for both Pinar and Lahn (1952) and Öcal (1968), which left about 60 % of the latters' primary sources to be identified.

The procedure followed with the double purpose of identifying Pinar and Lahn (1952) and Öcal's (1968) outstanding primary sources and of retrieving additional data on the seismicity of the area required the careful reading of a number of newspapers for the period 1899-1915. In particular, the set of the daily *Levant Herald*, published in Istanbul, *Hestia* (Athens) and *Amaltheia* (Izmir) were searched ; these were supplemented by *Stamboul* (Istanbul), *Neologos* (Istanbul) and *Makedonia* (Thessaloniki) for certain events. Further, some other Greek, Bulgarian, Russian and English papers gave occasional details of the more damaging events in the region. These newspapers provide more or less continuous coverage for the period 1899-15 ; however, it should be noted that reporting of the momentous political events of the latter years of the period took precedence over the reporting of smaller earthquake shocks, which renders the coverage somewhat uneven.

When such press information was entered into the worksheets the number of seismic events for the period of observation increased by a factor of 6 : press reports provided useful and detailed information for the more important events, and also revealed the existence of a number of relatively large shocks which were previously unknown. With the exception of erroneously- or incompletely-dated events, that is, events which were assigned the date of publication of the news or listed under the month of their occurrence only, almost all entries in Pinar and Lahn (1952) and Öcal (1968) were found mentioned in some form in the press. A check of all entries in Öcal also disclosed a number of mislocations of events, in which the geographical coordinates assigned by this author to the epicentral region mentioned in the press referred to a different locality of similar name in Turkey, or to a locality in Turkey at which a large distant earthquake with an epicentre outside the area of study was felt. In spite of these drawbacks, however, Öcal's catalogue remains, in the number of its entries, the most complete for the region.

Into this improved data set, purged of spurious and erroneous events, a separate larger body of information could then be incorporated. This consisted of all instrumental and macroseismic information contained in station bulletins of the time and in special seismograph station publications, i.e. Rudolph (1905), Oddone (1907), Tams (1908*a*, *b*), Christiansen and Ziemendorff (1909), Scheu (1910*a*, *b* ; 1911), Szirtes (1909, 1910, 1912*a*, *b* ; 1913), Scheu and Lais (1912), Sieberg (1917).

Table 1 is a conspectus of those seismograph stations operating throughout the world during the period 1899-1915 for which we have access to their weekly, monthly and/or annual bulletins. Weekly, monthly and annual reports all contain information about the onset times of the different phases recorded and the corresponding amplitudes and periods, data which were extracted and transferred to the appropriate worksheets for use in the relocation of the event and for the assessment of its magnitude. The monthly reports are usually more detailed than the weekly reports and occasionally include information regarding felt reports and damage descriptions, as well as supplementary information derived from private correspondence between the stations and European consuls near to the affected area.

Finally, the Ottoman newspapers *Ikdam* and *Sabah* and a number of provincial weekly newspapers (*vilayet gazeteleri*) of the period 1899-1915 were read. Rather few of the latter are still extant : those which are, however, proved to be a most valuable source of detailed local information. Thus, the Ottoman and foreign newspapers which have been read provide a continuous coverage for the period of interest ; territorially, coverage is also more or less complete, with Greek and Russian newspapers providing information for the western and eastern parts of the region respectively. While newspapers are the most important and exhaustive source of macroseismic information, additional details on the larger events were sought in the consular and diplomatic correspondence held at the Public Record Office (PRO) : except for the larger events before 1913, these were only rarely to be found. Together with information obtained locally from field trips between 1965 and 1971, relatively full coverage of earthquake occurrences during the period of interest has been established. The results of such analysis of each event are shown in table 2 which thus constitutes the earthquake catalogue for the period studied.

MACROSEISMIC INFORMATION

Dating of events

Together with the Gregorian calendar, the calendars in use in the Ottoman Empire during the period 1899-1915 were the fiscal solar calendar, locally known as *rumî* or *malî* — which is the Julian or Old Style calendar (O.S.) — and the Islamic lunar calendar, known as *hijrî*. The head of both provincial and Istanbul newspapers carried the date in one or more of these calendars as well as in the Gregorian or New Style (N.S.) calendar. However, individual news items within the papers — in our case, the reporting of earthquake occurrences — were usually found to be headed according to O.S. : this was not often explicit, but in the majority of cases was clear from the provision of additional information such as the day of the week on which the event occurred. (The Gregorian calendar was officially adopted in Bulgaria in 1916, in Russia in 1918, in Greece in 1922, in Yugoslavia in 1924 and in Turkey in 1926.) For the nineteenth century, and until 1 March 1900, 12 days must be added to the O.S. date to obtain the Gregorian or N.S. ; thereafter, 13 days are added, with local variations of one day arising because the Islamic day starts at sunset on the previous evening. During the period of our interest, the foreign language press of Istanbul, Izmir, Athens and other cities of the eastern Mediterranean reported local earthquake occurrences in N.S., but occasional errors in conversion from other calendars have been noted.

Throughout the present catalogue (table 2) dates are given in N.S., and times are shown in G.M.T., that is Istanbul civil time minus two hours. However, for a number of small local shocks reported by the press it has not been possible to define unequivocally the date of the event in N.S. The reason for this is that it is not invariably obvious from the context which calendar is being used, nor whether the day of occurrence of a given event is that of the week of issue of the newspaper or of the previous week. Such ambiguities may only be resolved when the same event is dated by different newspapers in different calendars. The dating of larger earthquakes rarely presents a problem, since, in most cases, these were widely reported in the press and were also recorded by seismograph stations.

A final difficulty which can arise is in the determination of the time of an earthquake. As mentioned above, the Islamic and the European day do not correspond. Whereas the European day is reckoned from midnight to midnight, the Islamic (and thus the Ottoman) day begins at sunset : a Thursday evening of the European calendar was therefore reckoned as the start of Friday by Ottoman timekeepers, for instance. This problem of dating is further compounded by the fact that the Ottoman day began at different times across the region, the time of sunset being later in the west than in the east (King, 1980).

In view of these difficulties in ascertaining the precise date and time of earthquakes, especial effort has been made not to duplicate events : therefore, although the time of some of the events of very small magnitude in our catalogue may be in error, this has not resulted in duplication.

Assessment of intensity

Information on observed effects for use in evaluating intensity in the MSK (Medvedev-Sponheuer-Kárnik) scale was obtained mainly from original sources, some of which are listed in the appended bibliography ; isoseismal maps of varying levels of detail were constructed for a considerable number of earthquakes for which there is sufficient information for this to be possible. Some of these maps are presented in this paper, and as can be seen from Ambraseys and Finkel (1986), there is precious little in the form of such maps for the period under investigation.

In order to assess the intensity of individual events on the MSK scale, study of well-reported events resulted in conclusion as to whether a shock reported in a particular locality was slight or felt, sharp or strong, severe or very strong, violent or very severe : intensities of III, IV, V and VI were assigned respectively. In most cases there was additional information that could help in determining the intensity of an earthquake using the criteria in the MSK scale ; secondary effects such as faulting, landslides, soil failures, and casualties were excluded since they are of limited value in assessing intensity.

For small or poorly-documented earthquakes, isoseismal radii r_i have been calculated by taking the average epicentral distances to locations of similar intensity. For the larger earthquakes, however, r_i values in table 2 have been computed from isoseismal maps of varying levels of detail. In assigning values to intensities $I \leq$ IV, great care has been taken to account for negative reports and for effects attributable to extremes of population density wherever this was possible. We have avoided the use of the radius of perceptibility r_0, vaguely defined as the distance up to which a shock was felt, and have instead used the radii for intensities II and III (MSK) explicitly.

Location of macroseismic epicentral regions

Data provided by the available macroseismic sources are generally adequate to permit relatively accurate location of the epicentral regions of earthquakes during the early part of this century. Even when there is no apparent indication of the epicentral region and no evidence of serious damage at any one of the various locations reported to have been affected, the location of the epicentral region may be estimated fairly closely : for small-magnitude events, that is where a shock was felt over a relatively small area, any instrumental location will result in errors much greater than the radius of the highest isoseismal, and so the epicentre may, with few exceptions, be determined more accurately from macroseismic information than from instrumental data for this early period.

On the other hand, for larger events, that is for earthquakes with relatively large felt areas, it is always possible to identify those localities of serious damage that define a more limited epicentral area, except when these encompass mountainous or sparsely-populated zones. Also, for the larger events it is always possible to ascertain the probable location of a macro-seismic epicentre from instrumental observation. However, it is very often the case that the available macroseismic information is inadequate to permit accurate assessment of the epicentral intensity and of the isoseismal of maximum intensity, so that the epicentral region of a relatively large shock is usually located with a margin of error comparable to the radius of the highest isoseismal available. The methodology used to determine epicentral regions is that developed for the study of the seismicity of Iran (Ambraseys and Melville, 1982). In most cases, then, the use of macroseismic data results in greater accuracy in the location of the epicentral region of an earthquake of the first half of this century in the eastern Mediterranean region than that allowed by instrumental estimates (Ambraseys, 1978).

Description of earthquake effects

This section deals with the felt effects of some of the larger events of the period. For earthquakes for which there is published information the annotation is kept as brief as possible, and we have added all pertinent references. (Information in station bulletins of the time (table 1) — particularly those of Russian, Italian, German and Austro-Hungarian stations — is too extensive to quote in detail, as is information in the local press : the latter is thus collectively cited as *Press Reports*. With few exceptions the detail provided by press reports, consular correspondence and notices in station bulletins is far superior to that found in published technical reports.) Place-names are those of the time of the earthquake, or in the original sources of information, and no attempt has been made to give

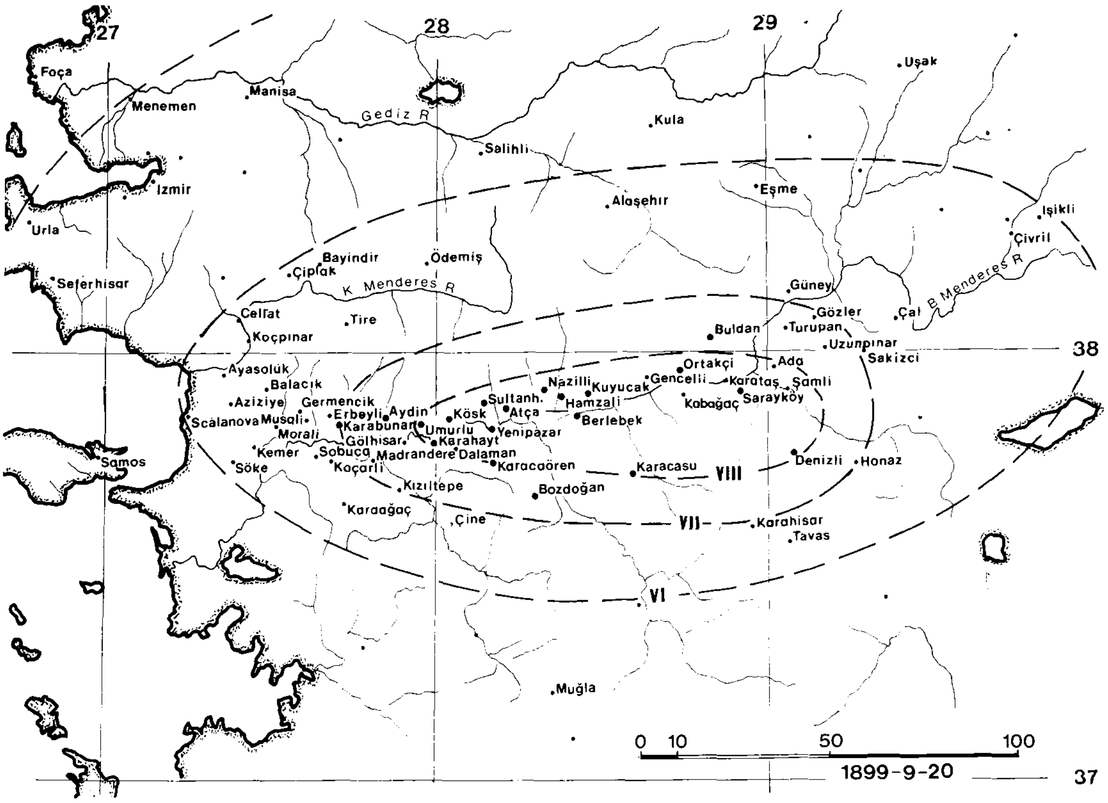

Figure 2

Isoseismal map of the Menderes earthquake of 20 *September* 1899, $M_s = 6.9$. *Larger dots indicate sites at which the intensity reached or exceeded* VIII (MSK). *Small dots show localities at which smaller intensities may be assessed. The data are insufficient to construct a more detailed isoseismal map.*

corresponding modern names : the location of some settlements has shifted, and others have disappeared altogether. The isoseismal maps that accompany this paper show a selection of the places affected (figs. 2-5). Location accuracies for the early maps used to locate the sites affected by the earthquakes described here vary for different parts of the region and they are not better than a fraction of a kilometre to a few kilometres for the central and southeast parts of the region. A list of these maps is given in the bibliography.

1899, September 20 ; Menderes valley (fig. 2) $M_s = 6.9$, $I_0 = \text{IX}$.

A destructive earthquake in the Menderes valley. Sultanhisar, Atcą, Nazilli, Kuyucak, Sarayköy, Denizli and Karacasu appear to have suffered more than other places. In Denizli, 55 % of the houses were completely destroyed. The havoc wrought at Nazilli was as great : the old town was totally ruined, together with Forbes' liquorice factory and all public buildings ; in the new part of the town, half the houses were ruined by the shock and the ensuing fire. In Sarayköy, the very few houses that survived the shock were consumed by fire. Damage was less serious in Aydin except in the Turkish quarter where a few hundred houses collapsed, together with two minarets of the Great Mosque, the chimney stack of Atkinson's machine factory and a number of churches and synagogues. The shock caused considerable damage to the railway line east of Aydin, towards Çal and Denizli : embankments slumped, leaving rails suspended 2 metres in the air and bridges were damaged at Balikdere, Gencelli and Karatas near Sarayköy. Telegraph communications were also interrupted east of Aydin, the poles supporting wires east of Kuyucak and Gencelli having collapsed. The shock triggered many landslides, one of which destroyed Ortakçi, which was abandoned ; Kemer and its nearby bridge, and sites west of Çine were also damaged by slides. Liquefaction-induced ground failures were reported from throughout the Menderes valley, particularly from near Koçarli, Sahinli and from as far as Cellat.

Long-period effects were experienced in Izmir, Muğla and Işikli, where a minaret was damaged, and the shock was felt as far away as Thrace, Marmara, Eskişehir and Rhodes. Small aftershocks, mostly in the western part of the epicentral region, and some locally damaging, continued well into 1900. The earthquake killed 1117 people and injured hundreds more ; it destroyed 7126 houses and damaged a further 8756.

Recent field-study by Allen and Sipahioğlu suggests that the earthquake was associated with normal faulting along a Quaternary break that extends from west of Aydin to east of Nazilli. Our field-studies confirm the existence of such a break that can be followed on the ground from near Ömerbeyli, passing through Kizilcali, very near Ilica, Umurlu, Baklaköy, Eskihisar, Atça, Dalca, Arslanli to Kuyucak, for a distance of 70 km with the south side downthrown by as much as 3 m. They also suggest that the whole length of this fault and its extension west of Ömerbeyli broke in the large earthquake of 23 February 1653, but that in 1899 only the segment east of Umurlu to near Sarayköy was involved in faulting, with the south block downthrown by less than 1 m.

Press Reports ; Anonymous (1899) ; Vincenz (1900) ; Anonymous (1900) ; Schaffer (1900) ; Cancani (1900) ; Sieberg (1932*b*) ; Pinar and Lahn (1952) ; Allen (1975) ; Sipahioğlu (1979).

1900, July 12 ; Kağizman $M_s = 5.9$, $I_0 =$ VIII.

A locally destuctive earthquake ruined dozens of villages in the region between Kars, Karakurt, Kağizman and Digor. Maximum damage was observed in a narrow zone running from Kağizman in the south, through Pasli and Karakilise in the north, within which landslides added to the damage. There were numerous, strong aftershocks. The earthquake killed 140 people, destroying 1100 houses and damaging 900.

Press Reports ; Debitski (1900) ; Levitski (1901) ; Byus (1948).

1901, March 31 ; Balchik $M_s = 6.4$, $I_0 =$ VIII (*).

This earthquake had an offshore epicentre in the Black Sea near Varna. Maximum damage was sustained by a small number of villages situated on the alluvial low-lands along the coast between Balchik, Kavarna, Blatnitsa and Limanu. Slumping of the coast destroyed many landing-places and coastal settlements including the lighthouse at Kaliakra. Large-scale landslides along the coast continued to develop for almost two weeks after the earthquake, disrupting communications and causing additional damage. The shock was felt throughout Bulgaria, southeast Romania, eastern Serbia and northwest Anatolia, causing great panic in Istanbul and on the Asiatic coast of the Bosphorus and the Marmara. Long-period effects lasting about a minute were reported from the Danube valley, from Szeged in Hungary, and from Odessa. The shock was perceptible in Saloniki, in Macedonia, in Dorohoi in Romania, and throughout the province of Sivas. Aftershocks continued until the end of July. The earthquake killed 4 people and injured 50 ; 1200 houses were destroyed.

Press Reports ; Cancani (1902) ; Gelescova (1902) ; Fitzner (1903) ; Watzov (1903) ; Mihailovic (1911) ; Popescu-Cernauti (1938, 1939) ; Réthly (1952) ; Florinesco (1958) ; Grigorova and Grigorov (1964).

1901, November 8 ; Erzurum $M_s = 6.1$, $I_0 =$ VIII.

Preceded by a series of foreshocks, an earthquake in the vicinity of Erzurum rendered 10000 people homeless. Damage was confined in the region between Hasankale, Hins and Erzurum, but the shock was very strongly felt in Kiği, Hinis, Sarikamiş and Aşkale. Many buildings in Erzurum were almost totally destroyed, including the military hospital, the prison, the courts of justice, the Armenian church and two Greek schools. Aftershocks, some of them damaging, continued to be felt in the region for eight months. No one was killed, but about 2000 houses were damaged beyond repair.

Press Reports ; PRO (1901).

1901, December 18 ; Ayvalik $M_s = 5.9$, $I_0 =$ VIII (*).

A damaging earthquake with an offshore epicentre in the Gulf of Edremit. Hundreds of houses were rendered uninhabitable in Ayvalik and on Mosko Is. ; the church of St. George and a school were badly damaged. Damage extended to Pelle, Dağlar, Assos and to the island of Chios. The shock was felt in Istanbul, Bursa, Aydin and Samos.

Press Reports.

1902, March 9 ; Çankiri $M_s = 5.5$, $I_0 =$ IX.

An earthquake with an epicentre near Korgun, preceded and followed by strong shocks, caused great destruction to the town of Çankiri and to nearby settlements : the 3000 houses of the town were almost totally destroyed. 4 people died and over 100 were injured. The shock was widely felt in central Anatolia.

Press Reports ; Lysakowski (1902).

1903, April 28 ; Patnos $M_s = 7.0$, $I_0 =$ X.

This earthquake, with an epicentre north of Lake Van, almost totally destroyed about 120 villages within a radius of 30 km, causing great loss of life. In the town of Malazgirt the military hospital and what remained of the city walls were utterly destroyed, while here and in Patnos, houses, mosques, churches and mills collapsed. Among those who perished were the commander, officers and men of the garrison at Malazgirt. Nearby villages were levelled with the ground, and about 20000 animals perished. The shock, which lasted some 60 s, was felt throughout eastern Anatolia ; it was not preceded or followed by any strong shocks, except for one damaging aftershock on 6 August, which had an epicentre between Gop and Malazgirt : this killed a number of people. The main shock killed 3560 and injured hundreds ; 12000 houses were completely destroyed.

Press Reports ; PRO (1903) ; Rudolph (1905) ; Levitski (1908) ; Tams (1908*a*, *b*) ; Sieberg (1932*b*) ; Byus (1948) ; Tchalenko (1977).

1903, May 28 ; Ardahan $M_s = 5.8$, $I_0 =$ VIII (?).

A destructive earthquake in the Göle region, south of Ardahan, ruined a number of villages between Varginis, Çardahli and Mehkerek. This earthquake is alleged to have killed over 1000 people.

Press Reports ; Levitski (1905) ; Byus (1948).

1904, August 11 ; Samos $M_s = 6.2$, $I_0 =$ VIII (*).

An earthquake with an epicentre off the south coast of Samos caused widespread damage to the island. The main shock and its violent aftershock destroyed a number of farming settlements and the monastery of St. Triada, and triggered rockfalls that blocked the roads along the south coast of the island. Damage extended to the island of Patmos and to the Anatolian coast west of Söke. The shock was strongly felt as far as Santorini, Chios, Menemen, Ödemis, Aydin and Chalki Is., off Rhodes. 4 people were killed and 7 injured, and 540 houses on Samos were totally destroyed.

Press Reports ; Eginitis (1909) ; Sieberg (1932*a*, *b*) ; Galanopoulos (1955).

1905,, October 21 ; Sukhumi $M_s = 6.5$, $I_0 = \text{VI}$ (*).

A relatively large-magnitude earthquake followed by an almost equally large aftershock was widely felt in the western Caucasus. Maximum intensities of not more than VI (MSK) were observed on the Black Sea coast at Sukhumi, Batum and Trabzon, suggesting an offshore epicentre associated perhaps with the much smaller event of 4 October which triggered a large seismic sea-wave that flooded the coast. Long-period effects were reported from great distances.

Press Reports ; Yaroslavtsev (1929) ; Byus (1941, 1948).

1905, December 4 ; Malatya $M_s = 6.8$, $I_0 = \text{IX}$.

An earthquake in the Şiro Çayi valley southeast of Malatya destroyed many villages between Pütürge and Çelikan with great loss of life. Damage extended to the southwest as far as Rumkale and to the plain of Malatya, where, near Izoli, the shock caused widespread liquefaction in the valley deposits of the Euphrates. Two closely-spaced aftershocks caused additional damage in the region of Abdülharab.

Press Reports ; Sieberg (1932*a*, *b*) ; Pinar and Lahn (1952) ; Plassard (1960).

1909, January 19 ; Foça $M_s = 5.8$, $I_0 = \text{IX}$.

A damaging shock with an epicentre in the region between Foça, Menemen and Güzelhisar caused the collapse of hundreds of houses within a radius of 15 km. The earthquake was not preceded or followed by any noticeable shocks, but it was very widely felt, as far as Dedeağaç and Piraeus. The shock triggered liquefaction in the flood plain of the Gediz river. The earthquake destroyed 700 houses and damaged 1000, and killed 8 people.

Press Reports ; Watzov (1911) ; Eginitis (1912).

1909, February 9 ; Enderes (fig.3) $M_s = 6.3$, $I_0 = \text{IX}$.

An earthquake followed by strong aftershocks caused extensive damage in the region between Zara, Ipsala, Koyulhisar and Enderes causing the destruction of many houses and the loss of some lives. The shocks were associated with ground ruptures in the vicinity of Karabayir, about 15 km south of the North Anatolian surface faulting of 1939, running discontinuously for several kilometres in an east-west direction, from Ipsala, along the north bank of the Tozanli Çayi, and crossing the Enderes-Zara road north of Köse Dağ. Their continuity and total length of about 15 km suggests tectonic origin, but we could find no conclusive field evidence for surface faulting. Ground fractures were also reported from further east, at Ezbider, while hot springs appeared at Yenice, and landslides, mainly due to aftershocks, blocked the Karaçam and Habeş passes to the south. The shock was strongly felt in Giresun, Tokat, Sivas and Kemah and it was perceptible as far as Kirşehir, Harput and the Caucasus.

Press Reports ; Riggs (1909*a*, *b*) ; Lysakowski (1910) ; Sieberg (1932*b*) ; Byus (1948).

1909, October 29 ; Karamürsel $M_s = 5.8$, $I_0 = \text{VII}$ (*).

Two shocks of almost the same magnitude, occurring in succession, caused widespread damage in the mountainous region of Koğlacik between the Gulf of Izmit and Lake Iznik. These earthquakes destroyed a

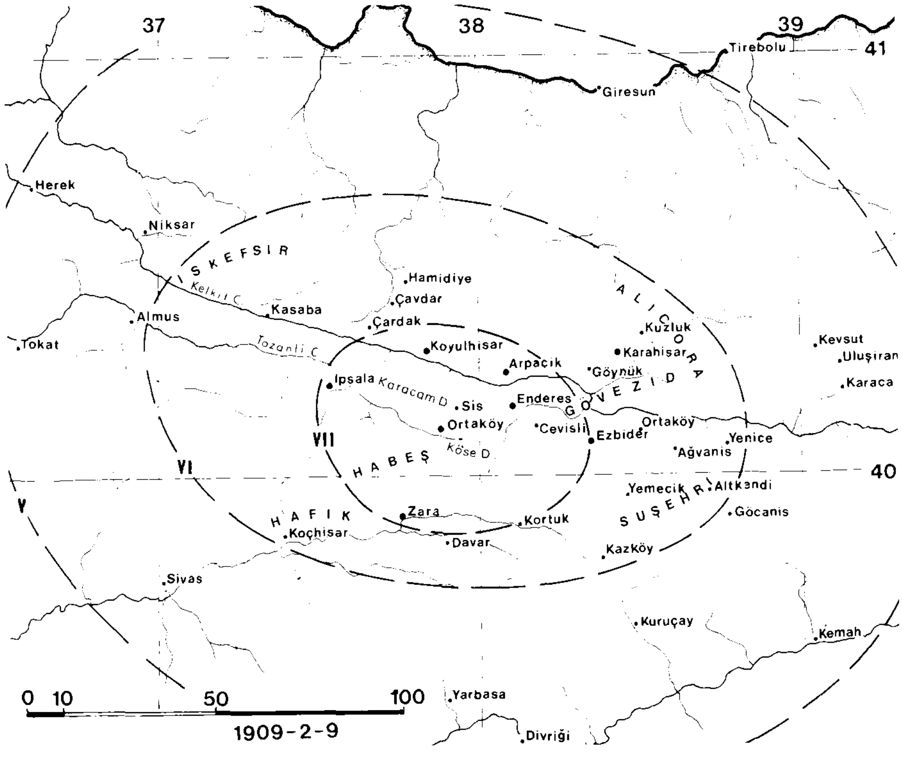

Figure 3

Isoseismal map of the Enderes earthquake of 9 *February* 1909, $M_s = 6.3$. *Larger dots indicate localities where the shock attained intensities greater than* VII (MSK) *and caused considerable damage. Sub-districts* (nahiyes) *reported to have been affected by the shock are shown in heavy capitals. (Karabayir is located between Ortaköy and Enderes.)*

number of houses and churches ; they were strongly felt at Çatalca, Terkos, Istanbul, Göynük, Bolu and Bursa, and were perceptible in Izmir, Gediz, Kütahya and southeast Bulgaria.

Press Reports ; Riggs (1909*a*) ; Watzov (1911) ; Eginitis (1912).

1910, June 25 ; Osmancik $M_s = 6.1$, $I_0 =$ VII (*).

Preceded by a widely-felt foreshock, an earthquake in the North Anatolian fault zone caused considerable damage in the region between Hacihamza, Osmancik and Iskilip. The foreshock was felt mainly to the north of the epicentral region, between Sinop, Samsun and Çankiri, while the main shock was felt to the south as far as Kirşehir, Ankara and Yozgat.

Press Reports.

1912, August 9 ; Saros-Marmara (fig. 4) $M_s = 7.4$, $I_0 =$ X.

A catastrophic earthquake in southeast Thrace destroyed 310 villages and towns and heavily damaged 272 other settlements making a total of 83633 people homeless. The main shock, followed in places by fire, its strong aftershocks and landslides, destroyed 313 churches and mosques and almost all public buildings within a radius of about 100 km. The earthquake was associated with a 50-km long surface fault-break, of a normal nature with a considerable right-lateral strike slip component that showed displacements up to 3 m. Liquefaction of coastal, river and lake deposits was observed in the epicentral region as well as at distances up to 200 km. The shock killed 2836 people and injured 7353 ; it destroyed 24980 houses and damaged a further 15000.

Ambraseys and Finkel (1987).

1914, May 28 ; Gemerek $M_s = 5.6$, $I_0 =$ VII (*).

A series of damaging shocks ruined a considerable number of houses and public buildings at Gemerek and nearby villages along the Kizilirmak. The main shock was strongly felt as far as Tokat, Sivas, Aziziye and Kayseri, and it was perceptible on the Black Sea coast as well as at Ladik, Herek, and Niksar.

Press Reports.

1914, October 3 ; Burdur (fig. 5) $M_s = 7.0$, $I_0 =$ IX.

A destructive earthquake centering on Lake Burdur killed more than 4000 people. The damage caused by the shock and the fire that followed was very great : more than 17000 houses were destroyed within a northeast trending zone about 90-km long and 30-km wide defined by Duvar, Yasiköy, Ilyas, Kilinç, Gönen and Barla. In Burdur, 90 % of the houses together with most of the historical monuments and the 20 m high clock-tower were destroyed. Kilinç was levelled with the ground and Keçiborlu lost 85 % of its houses. In Isparta 55 % of the houses, the Great Mosque and other public buildings collapsed. Damage and casual-

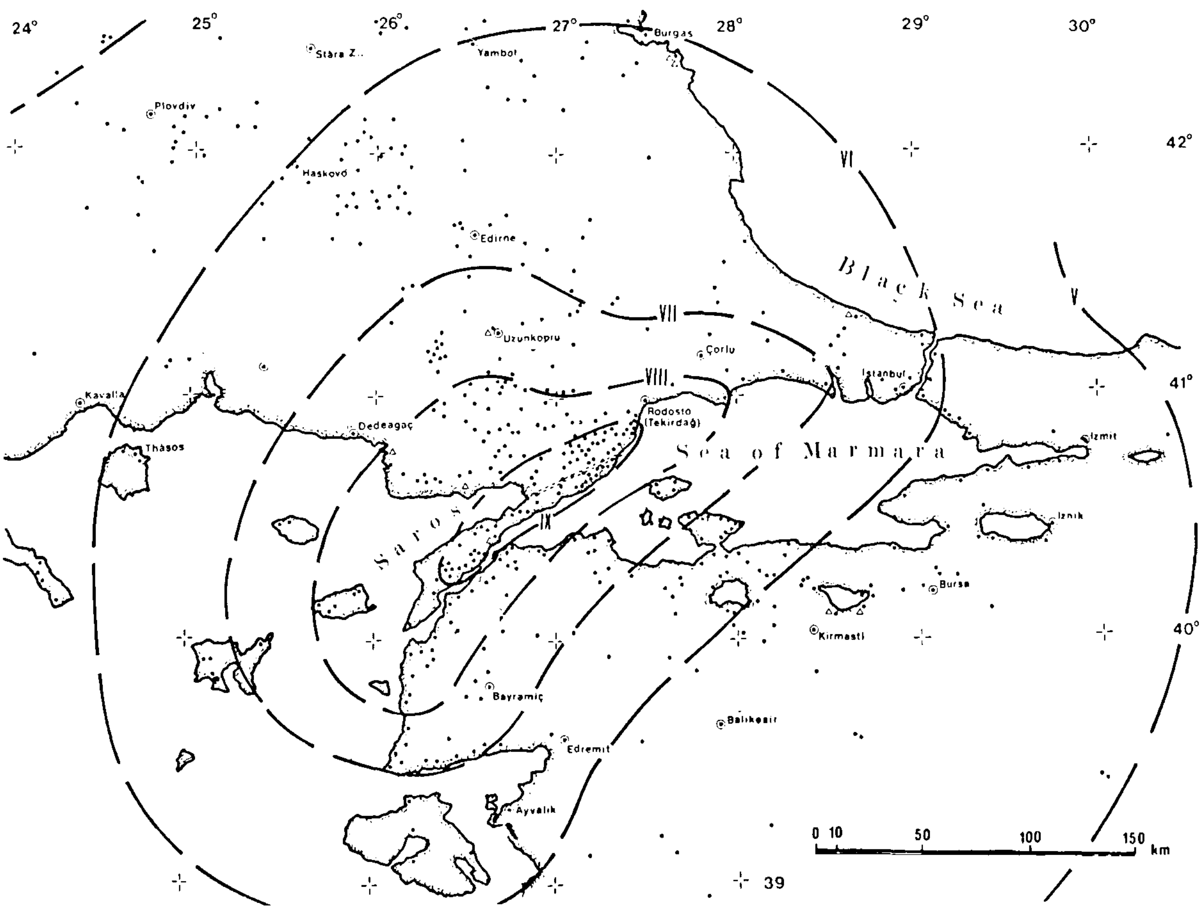

Figure 4
Isoseismal map of the Saros-Marmara earthquake of 9 *August* 1912, $M_s = 7.4$. *See Ambraseys and Finkel* (1987, *fig.* 5) *for details.*

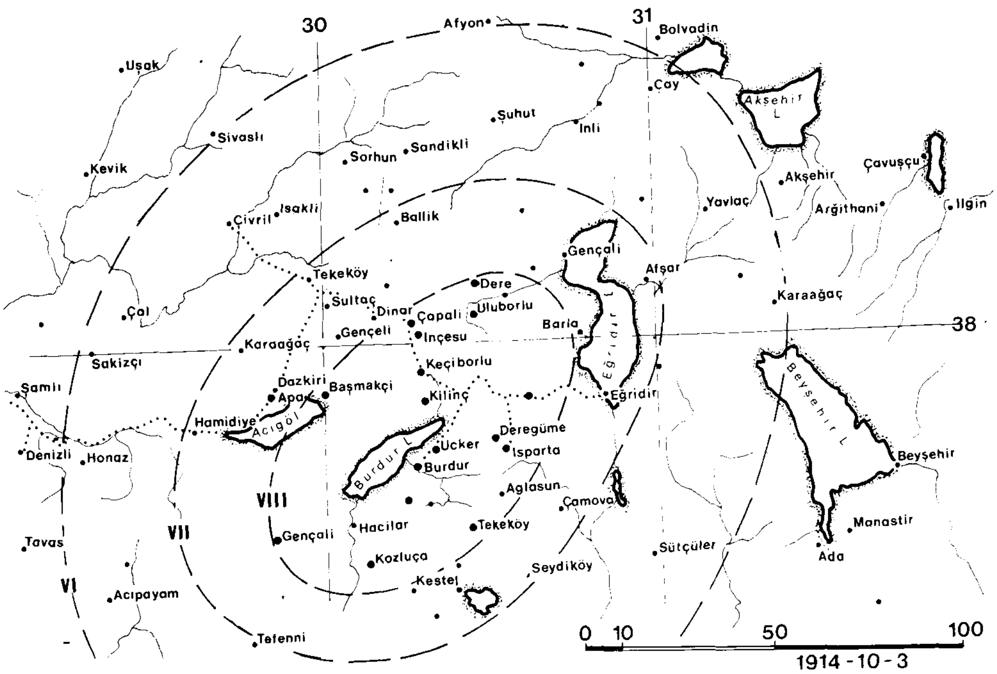

Figure 5

Epicentral region of the Burdur earthquake of 3 *October* 1914, $M_s = 7.0$. *Larger dots show places of* VIII (MSK) *or greater. Dotted lines show railway line which was damaged at a number of unspecified points. Data are barely sufficient to allow reliable plotting of the isoseismals.*

ties extended to Eğridir, Dinar and to other villages within a radius of 60 km. There was damage to the Dinar-Eğridir section of the railway line and to many villages as far as Denizli, Bolvadin and Antalya.

Although no clear-cut fault displacement has heretofore been documented in association with this event, the permanent submergence of the southeast coast of Lake Burdur for a length of 23 km, reported immediately after the event, suggests that significant surface faulting of a normal nature had occurred along this part of the shore, striking N-45°-E with the northwest (lake) side downthrown by as much as 150 cm. The main shock was followed by a brief sequence of small magnitude aftershocks.

Press Reports ; Pinar and Lahn (1952).

INSTRUMENTAL INFORMATION

Network of seismograph stations

Instrumental recording of earthquakes in the northeast Mediterranean area began late in the last century and continued for some time with instruments which operated in Europe and which were very imperfect by modern standards. In the early years of the period 1899-1915 most of such instruments were undamped, short-period, low-magnification pen-recorders, intended for the recording of local earthquakes. They were not capable of precision in the timing of an event. In the following years there was a rather rapid increase in the number of stations equipped with better recording instruments, i.e. medium-period, slightly- to critically-damped mechanical or electromagnetic seismographs which recorded photographically with magnifications in excess of 1000. Berlage (1932) contains a description of the various instruments in operation during this early period.

Figure 6 is a chronological conspectus of the seismological observatories in operation throughout the world in the period 1899-1915. The information used to construct this figure is given in table 1, which summarises the main characteristics of each operating station and the change over time. Table 1 lists all seismic stations, worldwide, which were operating during the period 1899-1915. It shows which stations were in operation at any particular time, the operating frequency and gain of the seismographs of each station, and whether the station bulletins report trace- or ground-amplitudes of the different phases of the earthquake recorded by the seismographs. Entries for a particular station and year show the magnification of the most modern seismograph of the station (first character), the average period of the instrument (second character), whether the station bulletin contains information about recorded amplitudes (third character) and periods of different phases (fourth character). Lower-case characters imply that the instrument is undamped or slightly-damped and that the amplitude reported is trace-single or -double amplitude. Upper-case characters signify damped instruments and ground amplitudes. Where one or more characters are missing from the four-character entry, it implies that the bulletin for the year in question omits that particular piece of information. Asterisks indicate years for which we have been unable to retrieve the available station bulletins. A plus-sign (+) indicates that a particular year has been incompletely reported in the station bulletins.

Although instrumental recording was only just beginning in the early part of this century, with insensitive instruments with uncertain timing, and with only poor

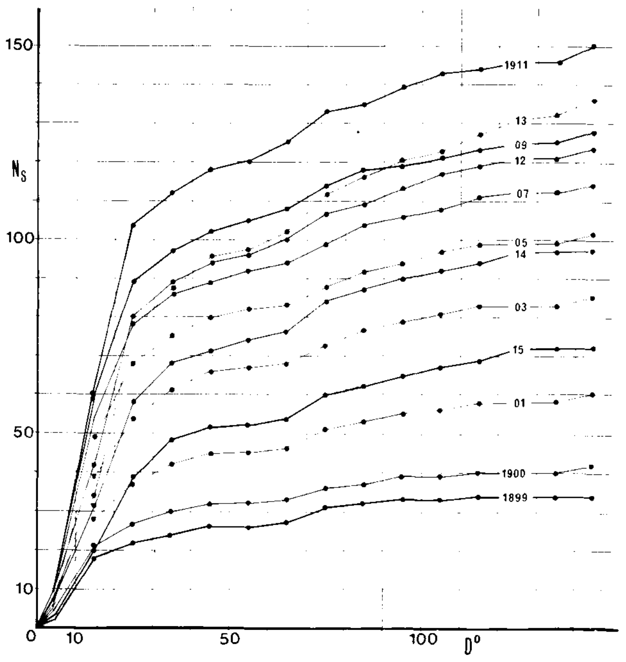

Figure 6

Cumulative distribution of the number of stations, N_s, operating during a particular year of the period 1899-1915 *as a function of their geocentric distance from Turkey,* D^0 *(taken from* 39° N-35° E). *Notice the shape of these curves which show the non-uniform distribution in space of the worldwide network of the time, with* 65 % *of the total number of stations in operation located at distances less than* 30° *from Turkey. Notice also the rapid decrease in the number of stations after* 1911 : *this is partly compensated for by the introduction of more sophisticated instruments (cf. table* 1).

knowledge of earthquake travel times, there is a vast amount of instrumental data for the period that is capable of being analysed but which has hitherto been neglected. From figure 6 we notice that the number of seismographic stations worldwide stood at 149 by 1911, with more than 200 instruments in operation, and with a very rapid increase in the number of stations equipped with proper recording instruments (table 1). During the decade after about 1911 the amount of available seismographic information begins to fall off, particularly because of the First World War. However, it was the drastic discontinuity in regular reporting of events rather than the closure or suspension of stations which caused the decrease in information during these years, and although it is certainly the case that many station bulletins of the war period were not published or widely-distributed, in a number of stations the original bulletins are still extant in manuscript form. Local station bulletins, such as those of the Caucasus network, of Ksara in Lebanon, of Athens, and of Harput in eastern Turkey, contain valuable instrumental and occasionally macroseismic data which help in the assessment of the location and magnitude of even relatively small earthquakes in the region. In particular, it is hoped that the retrieval of the seismographic station bulletins of the schools of Sacré-Cœur in Izmir and of St-Benoit in Istanbul, which cover the period of our present interest, will add to our knowledge of the local seismicity of the region.

Instrumental location of epicentres

During the years 1899-1915 the BAAS and certain seismograph stations in Russia and Germany published a number of epicentral locations of the larger shocks of the period, macroseismic information often being used to supplement the instrumental in order to determine the approximate position and time of origin of a seismic event. The use of macroseismic data ensured that such determinations were reasonaly accurate ; when macroseismic data were not available however, as was the case for many of the smaller shocks, the instrumental epicentres are sometimes found to be in gross error.

Accordingly, we have re-examined the early instrumental locations in the present area of study and in a few instances have added new, reasonably accurate determinations. Such re-locations depend heavily on observations from European stations, which subtend only a limited range of azimuth for events in the northeast Mediterranean. Unfortunately, very few stations operated in other quadrants throughout the period, but readings from Russian stations provide a measure of control.

Early BAAS locations were based on observations reported from undamped seismographs. The Milne instruments mainly recorded surface waves, and the early bulletins report the onset of these and the time of maximum amplitude. Only occasionally are « preliminary tremors » of body-waves reported, and these are of doubtful interpretation. Following a technique used by Ambraseys and Adams (1986) we found that consistent locations could be obtained by assuming that the reported maximum phase travelled with a velocity of about 2.85 km/s : this would correspond to an Airy phase in continental propagation. Slightly different values were taken for different events. A similar technique was used by Abe (1985) to determine origin-time and magnitude for earthquakes of this period with known locations in other parts of the world. By means of a simple graphical procedure on a globe, we could generally obtain a solution estimated to be accurate to within 2° to 5°. Some events were confirmed close to the original BAAS location but others were found to have been grossly mislocated. The reading of body-phases taken from station bulletins for the later part of the period, by which time more sensitive, damped instruments had been installed widely in Europe, sometimes allowed the identification of *P*-, *PP*- or *S*-phases, which in turn permitted greater accuracy in origin times and confirmed the epicentral locations derived mainly from surface-wave maxima or from macroseismic observation.

Nevertheless, the accuracy of instrumental locations remains very poor throughout the period and is certainly inferior to that with which epicentres may be ascertained from macroseismic data. This is particularly true for small, poorly-recorded events. Consequently, macroseismic location of epicentres has been preferred to instrumental, except where events occurred offshore or in areas of sparse population (table 2).

REVISION OF MAGNITUDES

Effective magnitude assessment of earthquakes in Turkey begins in 1902 with the recordings by Wiechert instruments at Potsdam, and the number of stations reporting ground-amplitudes and periods increases rapidly with the addition of Jena, Leipzig, Strasbourg, Uppsala and other reliable stations.

For the period 1899-1915 the number of earthquakes in the northeast Mediterranean region for which magnitudes are reliably known is very small indeed : the magnitudes available for the period are either non-homogeneous or else it is not clear how they were derived. In our study, therefore, individual surface-wave magnitudes were calculated using the standard procedure put forward by the IASPEI Commission on Practice (Willmore and Kárník, 1971) and the method described in Ambraseys and Melville (1982). The most appropriate formula is :

$$M_s = \log (A/T) + 1.66 \log (D) + 3.3 + C_i \quad (1)$$

where (A/T) is the maximum value of the ratio of the ground-amplitude A of the surface-wave group in microns, and T the corresponding period in seconds. D is the focal distance in degrees and C_i is the station correction.

Almost all estimates of M_s were made from *LH* amplitudes, which constitute the bulk of the available information. In the few cases of amplitudes recorded at relatively short distances by stations such as Athens, Harput and Tiflis, these were treated as *Lg* (*Sg*)-phases.

Body-wave magnitudes were estimated using Gutenberg's distance-depth factor $Q(D, h)$ for distances in excess of 15°, i.e. from

$$m = \log (A/T) + Q(D, h) \quad (2)$$

and for whichever phase amplitude-period data were available. We combined magnitude estimates from *PH*-, *SH*- and *PV*-phases and took an average for body-waves in which *PH*-phases dominate.

Errors in the estimates of surface-wave magnitudes are relatively small, and the mean of the standard deviation of the M_s values of 83 events, without station corrections, is 0.3 ($\pm$ 0.15) units of M_s. With station corrections, the values of which are shown in table 2, the standard deviations were reduced to 0.2 ($\pm$ 0.10) and their effect on M_s estimates is small except for those events recorded by a small number of stations, that is, for small-magnitude events.

The station correction C_i is defined by

$$C_i = (M_n - M_i)/n \quad (3)$$

where M_i is the magnitude of a particular earthquake at a particular station i, and M_n is the average value of the magnitude of the same event estimated from a number of stations ; n is the total number of earthquakes for which M_n and M_i estimates are available. Table 3 summarises the station corrections C_i, the number of earthquakes available for the northeast Mediterranean region (n) and for a much larger area that includes the Balkans and Iran (n_0), used to estimate C_i, and the standard deviation (dC). For a number of stations C_i was found to vary erratically with time, this fluctuation being associated with either the improvement or replacement of seismographs and also with changes in the accuracy of the reporting of amplitude-period data. The resulting values of C_i, shown in table 3, are fairly consistent with those obtained by Kárník (1968).

Errors in the estimation of body-wave magnitudes are likely to be greater than those for surface-waves. This is mainly due to the lack of information concerning focal depths, which for most events are known only approximately, and also due to the small number of reliable stations reporting data at distance greater than 15°. The data available for the region and for the period of interest are insufficient to provide station corrections for body-wave magnitudes whose mean standard deviation, for 32 events, is 0.3 ($\pm$ 0.1) units of m.

The comparison of the calculated M_s and m magnitudes with those previously estimated by others for the period 1899-1915 is difficult, since only relatively few events during that period have been assigned magnitudes. The only body of information with which our M_s estimates may be compared is that in Kárník (1968), repeated also in Shebalin *et al.* (1974) : there was found to be hardly any difference between these two sets of estimates, Kárník's values being slightly higher. Gutenberg and Richter's (1965) few estimates of M_s during the period are also systematically higher than those which we have derived, by 0.3 units of M_s, a trend noted elsewhere (Ambraseys and Melville, 1982). It is worth mentioning that Gutenberg's notes and worksheets, which form the basis of the published work Gutenberg and Richter (1965), suggest that in assessing magnitudes he relied to a considerable extent on personal judgement, not only in his selection of data, but also in the way in which he combined the results from different phases to arrive at a final estimate of magnitude. For most of his calculations he used fewer stations than the number for which data were available at the time, omitting those considered by him to be unreliable. There are unfortunately no previous estimates of body-waves with which ours may be compared.

Thus it has been possible to assign M_s and m values to 118 and 47 events respectively, and to increase by a factor of 2.5 the number of earthquakes for which instrumental magnitudes may be uniformly determined. The magnitude of individual events, the standard deviation and the number of observations used are shown in table 2.

Magnitude determination in the early period 1899-1913 can be estimated from the maximum reported trace-amplitude of the Milne instruments, using a formula derived by Ambraseys and Melville (1982) which take account of the response of the undamped instrument to earthquakes of different magnitude :

$$M^* = \log (2A) + 1.251 \log (D^0) + 4.06 + C_j \quad (4)$$

where $2A$ is the peak-to-peak trace amplitude in millimetres, D is the distance in degrees, and C_j is a station correction. This equation has been derived for events within an area of radius of about 25° from central Iran, that includes Turkey, and it is valid for magnitudes less than 7.7. A similar relation has been derived by Abe (1985).

Using equation (4) the value of M^* of 103 earthquakes was determined from 460 station magnitudes with a mean standard deviation of ± 0.3 (± 0.2). For 67 of these 103 events we have also estimated the magnitude M_s, with station corrections, from equation (1). Consequently we may proceed to estimate the station correction C_j in equation (4) using the definition :

$$C_j = (M_s - M_j^*)/n \qquad (5)$$

where M_s is the corrected surface-wave magnitude of an event from equation (1), M_j^* is the station magnitude derived from the Milne amplitudes and equation (4) for the same event, and n is the number of earthquakes for which M_s and M_j^* estimates are available. Table 4 shows the station correction C_j, the standard deviation and the number of observations used, together with the station correction derived by Abe. It should be noted that the station correction derived by Abe (1985) is based on an equation similar to (3) rather than (5), reflecting the magnitude of the residuals from the average M^* rather than M_s. Nevertheless, his results are fairly consistent with ours.

Magnitudes M^* were obtained by averaging values calculated from individual Milne station readings, including the station correction C_j, and entered in table 2 which shows also the standard deviation and number of stations used. For corrected M^* values the mean of the standard deviation was reduced to ± 0.2 (± 0.1), a value identical with that derived for C_i. A comparison between M_s and M^* for $n = 67$ events for which both magnitudes are available, is shown in figure 7, with a major-axis solution :

$$M_s = -0.66 + 1.10\, M^* \qquad (6)$$

and $s = 0.19$. Equation (6) was then used to correct further M^* and convert it into M_s, for those earthquakes for which no M_s determination was possible. This increased the number of events with known magnitude to over 150.

We may now proceed to assess the surface-wave magnitude of shallow earthquakes in terms of I_i and r_i. This can be done by fitting the sets of I_i, r_i and the corresponding value of M_s or M^* in table 2 to an equation of the type

$$M_F = a + bj^{-1}\sum I_i + cj^{-1}\sum r_i + dj^{-1}\sum \log\,(r_i) \quad (7)$$

where j is the number of isoseismals available for the determination of the average value of the surface-wave magnitude of a particular event and a, b, c and d are the constants to be determined. Equation (7) was, in fact, fitted to 494 sets of values of M_s (or M^*), I_i and r_i, for shallow earthquakes in our region over the much longer period 1899-1986, with the following results :

$$M_F = -0.53 + 0.58\, j^{-1}\sum I_i + 1.96\times 10^{-3}\, j^{-1}\sum r_i + 1.83\, j^{-1}\sum \log\,(r_i) \quad (8)$$

and with a coefficient of determination of 0.94. A comparison between M_s and M_F, predicted in equation (8) for the period 1899-1915, shown in figure 8, implies that the data set for the period 1899-1915 also satisfies equation (8). This also implies that for shallow events with $r_i \geqslant 15$ km, the effect of focal depth on M_F is negligible. M_F is the equivalent surface-wave magnitude in terms of felt effects.

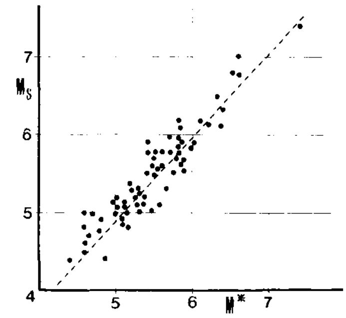

Figure 7

Comparison between standard surface-wave magnitudes M_s and magnitudes M^* determined from Milne instruments (eq. 4) for earthquakes in the northeast Mediterranean region, in the range $4.0 \leqslant M_s \leqslant 7.5$.

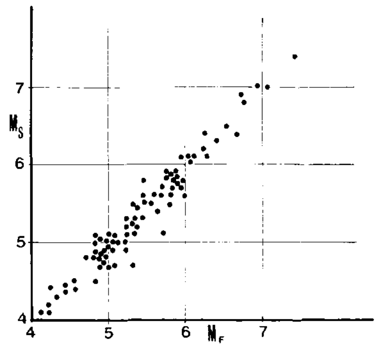

Figure 8

Comparison between standard surface-wave magnitudes M_s and magnitudes M_F calculated from macroseismic data for northeast Mediterranean earthquakes in the range $4.5 \leqslant M_s \leqslant 7.5$.

Equation (8) was used to assign magnitudes to events for which no instrumental data is available but for which there are values of r_i and I_i. Thus, equivalent magnitudes M_F were assigned to 229 events, mainly of small magnitude (table 2), bringing to 380 the total number of events for which magnitude may be determined.

CONCLUSIONS

Table 2 lists all earthquakes retrieved for the period 1899-1915, a total of 760 events including the larger foreshocks and aftershocks, that is, the smaller shocks from the same epicentral region that precede or follow the main shock by a few days or months respectively. Information on these events has been extracted from a wide variety of sources and compares with the 134 events for the period given by Öcal (1968), and 90 and 86 events respectively by Ergin *et al.* (1967) and Pinar and Lahn (1952). Other available catalogues list far fewer still (Mihailovic, 1927 ; Plassard, 1960 ; Öcal, 1961 ; Plassard and Kogoj, 1968 ; Kárník, 1968, 1971 ; Kondorskaya and Shebalin, 1977 ; Soysal *et al.*, 1981).

Figure 9 shows a plot of the localities from which shocks were reported as felt at a single place (points *c*) and of the epicentres of small events with $M \leqslant 4.9$ (points *a* and *b*) — but excluding fore — and aftershocks : here we can see that contemporary press reports and other sources of information provide a fairly unbiased sample in terms of population density and distance from the larger centres of communication. Thus, the number of small events reported from the remote areas of eastern and southeastern Anatolia, from Hakkari and Elaziğ provinces for instance, is not significantly less than those reported from around Istanbul, Bursa and Izmir : the only difference is that reports of events in the remoter areas appeared in the press after considerable delay.

One notable conclusion to be drawn from figure 9 is that a thorough search in the contemporary press and the proper interpretation of the data therein may provide information as detailed as the world network of seismograph stations of the late 1950s, if not better. Another conclusion is that if such a condition is satisfied for the small events depicted in figure 9, i.e. $M \leqslant 4.9$, no larger magnitude events are likely to have been missed out. A possible exception may be small events which occurred in Thrace and in the area to the northeast of Erzurum during the military operations there in 1912-13 and 1914-15 respectively.

Figure 10 shows the distribution of epicentral regions of all earthquakes of the period 1899-1915, excluding foreshocks and aftershocks. This 17-year period is dominated by the three large shocks of $M_s \geqslant 7.0$ of Patnos, 1903, in the east, Saros-Marmara, 1912 in the northwest and Burdur, 1914 in the southwest ; it is also characterised by the relatively high level of activity of the East Anatolian fault zone i.e. the Taurus zone that extends along the line of Maraş-Elaziğ-Bingöl, and which has been relatively quiet during the last few decades. A relatively high level of activity is also apparent on the North Anatolian fault zone between Amasya and Suşehri and near Tosya, but with most of the segments of this zone, which broke between 1939 and 1967, showing no signs of activity during the period 1899-1915. Relatively high, diffused seismicity is also noticed in the Erzurum-Kars-Caucasus area and in western Anatolia in the region of Izmir-Balikesir-Eskişehir-Aydin-Muğla.

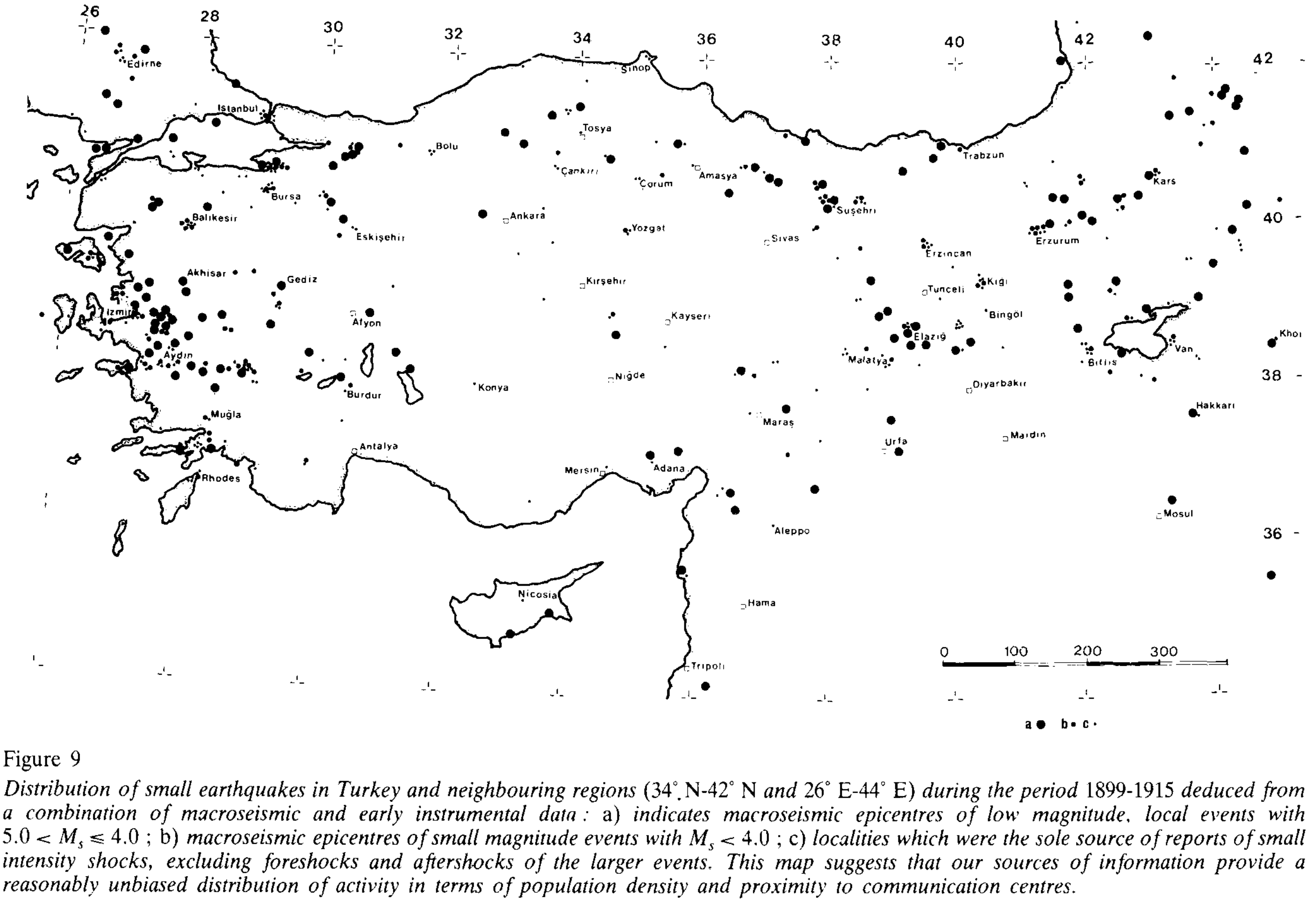

Figure 9

Distribution of small earthquakes in Turkey and neighbouring regions (34°.N-42° N *and* 26° E-44° E) *during the period* 1899-1915 *deduced from a combination of macroseismic and early instrumental data :* a) *indicates macroseismic epicentres of low magnitude, local events with* $5.0 < M_s \leqslant 4.0$; b) *macroseismic epicentres of small magnitude events with* $M_s < 4.0$; c) *localities which were the sole source of reports of small intensity shocks, excluding foreshocks and aftershocks of the larger events. This map suggests that our sources of information provide a reasonably unbiased distribution of activity in terms of population density and proximity to communication centres.*

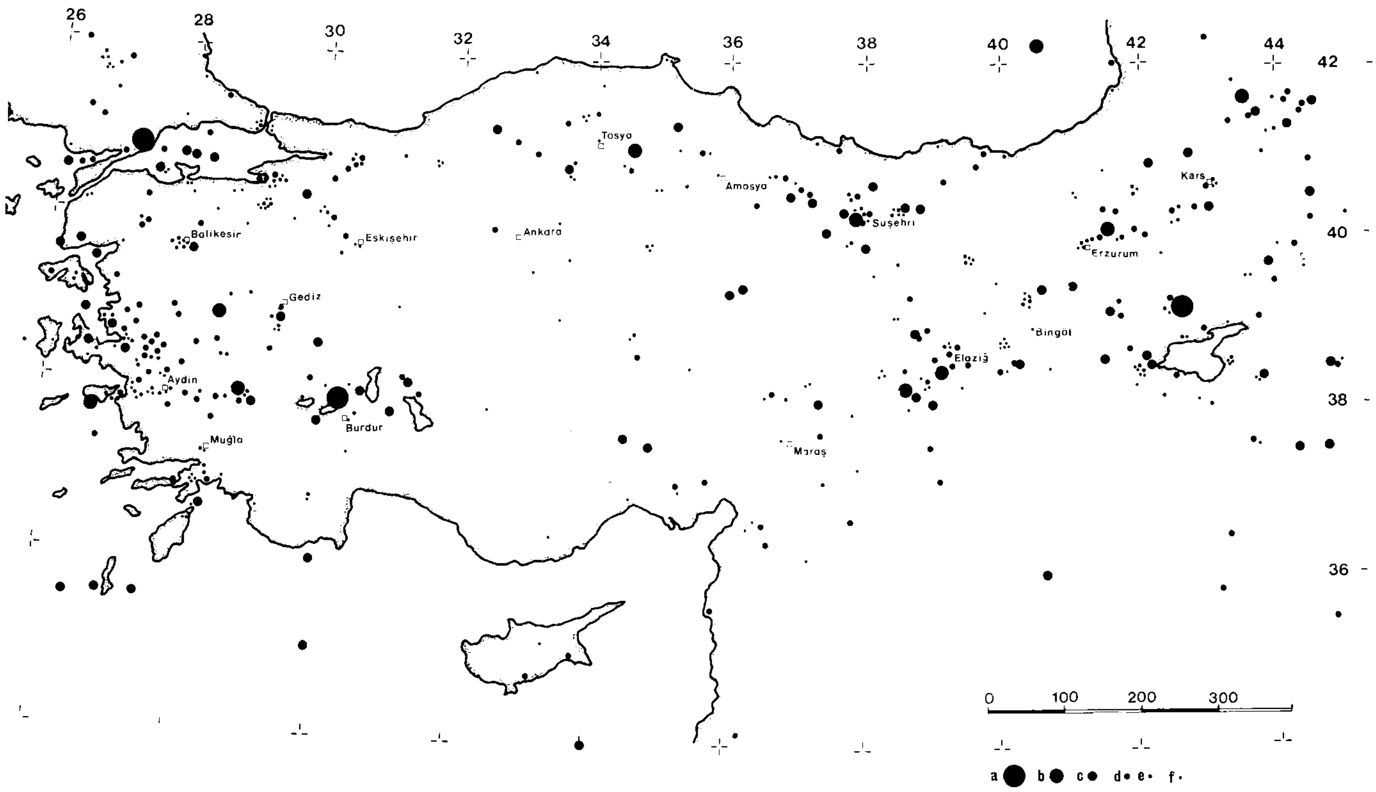

Figure 10

Distribution of macroseismic epicentres, excluding foreshocks and aftershocks, for the period 1899-1915 *:* a) $7.5 > M_s \geq 7.0$; b) $7.0 > M_s \geq 6.0$; c) $6.0 > M_s \geq 5.0$; d) $5.0 > M_s \geq 4.0$; e) $M_s < 4.0$; f) *very small local shocks felt only at one place.*

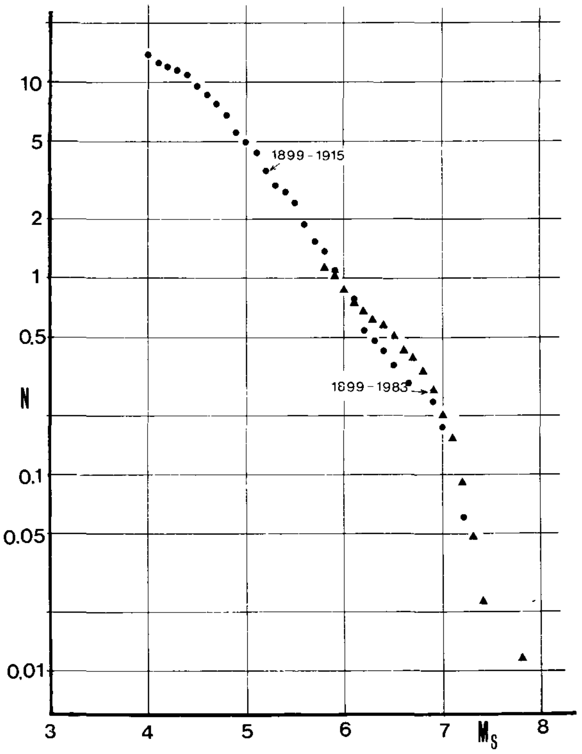

Figure 11

Cumulative frequency distribution of earthquakes in Turkey and neighbouring regions (34° N-42° N *and* 26° E-44° E) *shown in figure* 1. *Solid circles : for the period* 1899-1915 *; solid triangles : for the period* 1899-1983. *N is the annual number of earthquakes in the region of magnitude equal to or greater than* M_s.

Figure 11 shows the cumulative frequency distribution of earthquakes — excluding foreshocks and aftershocks — with $M_s \geq 4.0$ in the whole region for the period 1899-1915 (solid circles). On the same plot we have superimposed the data for the same region but for the longer period 1899-1983 for which we have uniformly-assessed M_s values in excess of 5.7 (solid triangles). It is interesting to note that the two distributions coalesce in the range of common magnitudes, confirming that, in this range, the very short period sample of 1899-1915 is representative of the regional activity that can be deduced from a period of observation five times as long. The shape of the combined frequency distribution is of course not linear for the whole range of magnitudes. For the range 4.5 to 6.5, a magnitude range that represents a « background » activity independent of the large-scale tectonic elements, the *b*-value, is found from figure 11 to be about $b = 0.7$. At the upper end of the recurrence curve, where the frequency distribution reflects activity of large tectonic structures, it steepens to values of $b = 1.5$. However, because of the very long waiting times or return periods required to sample large events, much longer than the period of 85 years between 1899 and 1983, and also because of the boundary conditions of the region over which we are sampling the activity, the precise way in which the recurrence curve steepens is not yet clear.

A 17-year period of observations is hardly sufficient to allow conclusions to be drawn about the long-term seismicity of the region. However, these observations show that many other parts of the region, removed from the North Anatolian fault zone, are capable of producing earthquakes of magnitude in excess of 7.0, that the present-day quiescence of the Taurus region is only temporary, and that it is possible, by combining early instrumental data and macroseismic information to investigate in considerable detail the seismic activity of a region during the first part of this century.

It is the association of felt reports with instrumental data which provides the best guide for the identification of the larger events in a region. Even in the absence of detailed macroseismic data, amplitude and period information, or even only the number of reporting seismograph stations, may be used to assess the relative magnitude of an event. Indeed, some of the larger events, particularly those in sparsely-inhabited areas, or those with offshore epicentres, could not have been identified solely from their felt effects. Conversely, the magnitude of a number of events in western Anatolia has been overestimated : without instrumental data it would have been impossible to recognise as small, events in densely-populated areas which have been assigned abnormally high magnitudes on account of their large epicentral intensities.

Even when the instrumental data for earthquakes of the period are, taken alone, insufficient to allow a relocation of the event, they are found to be of value when analysed in conjunction with macroseismic data. The number of stations recording an event for which we have sufficient macroseismic data, the amplitudes and periods recorded, the maximum distance at which the event was detected by instruments — all these provide valuable information from which we can assess the size or magnitude of an event.

All of the relatively large earthquakes identified for this period in the press were found to have been recorded by the seismographic network of the time : conversely, only very few events in the area that are known to have been recorded instrumentally, and whose location was thus roughly known, escaped coverage in the press. Indeed, an absence of press reports concerning an earthquake located by instruments, and particularly those thought to have taken place on land, was generally found to mean that the instrumental location was seriously in error : such seemingly negative evidence proved to be of great value in the relocation of certain events.

In conclusion, the method used here to assess the seismicity of the northeast Mediterranean region during the period 1899-1915 may also be used to extend our knowledge of seismicity during earlier periods of time for which no instrumental but only macroseismic information is available (*).

Acknowledgements

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(*) The following summary of the work involved in preparing this study may prove useful to those who would like to apply this methodology to the study of historical earthquakes in other parts of the world :

— 20 man-months of retrieval of data by a full-time researcher familiar with local history, geography and language (in the present case both modern and Ottoman Turkish, as well as French and German) ;

— 12 man-months of processing of both macroseismic and instrumental data by an experienced engineering seismologist with sufficient background knowledge of the seismicity and tectonics of the region ;

— 4 man-months of retrieval of data from Greek, Yugoslav, Bulgarian and Russian sources, mainly newspapers and technical reports ;

— access to national and local libraries in London, Istanbul, Ankara, Athens ;

— availability of an almost complete set of station bulletins of all seismograph stations in operation during the period ;

— a small amount of computing facilities and advice from experienced colleagues.

TABLES

Table 1

Conspectus of worldwide seismograph stations 1899-1915.

T_0 V	0-5″	6-10″	11-15″	16-20″	20″
0-20	1A	1B	1C	1D	1E
21-50	2A	2B	2C	2D	2E
51-100	3A	3B	3C	3D	3E
101-200	4A	4B	4C	4D	4E
> 200	5A	5B	5C	5D	5E

Key :

T_0 = natural period of seismograph in seconds
V = gain of instrument
a = undamped
A = damped
SC = seismograph station code (US Geological Survey Circular 791, 1978)
D^0 = geocentric distance of station from northeast Mediterranean, taken from 39° N-35° E
M = ground amplitude reported in microns
T = period in seconds
m = trace amplitude reported in millimetres
t = period in seconds
* = not available
\+ = incomplete.

For the different types of seismograph in use at the time, see Berlage (1932).

Note : the authors would be grateful to receive spare copies of station bulletins for the period before 1952.

TABLE I

Station	SC	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	D°	Country
Aachen	AAC	-	-	-	-	-	-	-	5C*	5C*	5C*	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT		23	GER
Abbassia(Cairo)		1cm	1cm	1cm	1cm	1cm	-	-	-	-	-	-	-	-	-	-	-	-	10	EGY
Adelaide	ADE	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	*	*	121	AUS
Akhalkalaki	AKH	-	-	-	-	1em	1em	1em	1em	1em	1em	1em	*	*	-	-	-	-	6	RUS
Accra		-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	46	GAN
Algiers	ALG	-	-	-	-	-	-	-	-	-	-	-	4Bm	4Bm	4Bm	4BMT	-	-	25	ALG
Apia	API	-	-	-	-	*	*	4C	4C	4C	4C	4C	4C	4C	4C	4C	-	-	146	SAM
Ascension Isl.		-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	-	-	65	ASC
Athens	ATH	1am	1am	1am	1am	1am	1amt	1amt	1amt	1amt	1amt	1amt	1amt	3Bmt	3BMT	3BMT	3BMT	3BMT	10	GRE
Azores	PDA	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c+	1c+	1c+	47	POR
Baku	BAK	-	-	-	-	2d	2d	2d	1cm	1cm	2d	2d	2d	2d	5EMT	5EMT	5EMT	5EMT	12	RUS
Balakhani		-	-	-	-	2d	2d	2d	2d	2dm	2d	2d	2d	-	-	-	-	-	12	RUS
Baltimore		-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	*	*	-	-	95	USA
Barcelona	FBR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?MT+	?MT+	25	SPA
Batavia	DJA	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	*	-	*	*	*	80	INO
Batumi		-	-	-	1e	1em	1em	1em	1em	1em	1em	1em	1em	-	-	-	-	-	6	RUS
Beirut		-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c+	1c+	-	5	LEB
Benevanto	BNV	-	-	1a	1a+	1a+	1a+	1a+	1a+	1a+	1a+	1amt	1amt	2B	*	2Bm	-	-	15	ITA
Beograd	BEO	-	-	-	-	-	2am	2am	2am	2amt	2am	2am	-	3AMT	4BMT	4B+	4BMT	-	13	YUG
Bergen	BER	-	-	-	-	-	-	1dmt	1dmt	-	-	-	1dmt	1dmt	1dmt	1dmt	1dmt	-	28	NOR
Berkeley	BKS	-	-	-	-	-	-	-	-	-	-	-	MT	MT	MT	MT	MT	MT	100	USA
Bermuda	BEC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	?	-	-	77	BER
Besancon	BES	-	-	-	-	-	-	-	-	-	-	-	3B	3B	3B	3BMT	-	-	23	FRA
Biberach	RAV	-	-	-	-	-	-	-	-	-	-	-	-	2BMT	2BMT	2BMT	2BMT	2BMT	20	GER
Bidstone	BID	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	*	30	UK
Bochum	BUG	-	-	-	-	-	-	-	-	*	*	*	-	5CMT	5C	2BMT	-	-	23	GER
Bologna	BOL	-	-	-	-	-	-	-	-	3a	3a	3amt	3a	3a	*	3am	-	-	19	ITA
Bombay	BOM	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	38	IND
Borzomi	BOR	-	-	-	-	1em	1em	1em	1em	1em	1em	1em	1em	5C*	5C*	5C*	5C*	5C*	7	RUS
Breslau		-	-	-	-	-	-	-	-	-	5CMT+	5CMT+	5CMT	5CMT	5CMT	5CMT	5CMT+	-	17	GER
Bromwich	WBE	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1c*	1c*	1c*	1c*	29	UK
Bucuresti	BUC	-	-	-	-	1d	1dm	1dm	1dm	1d	1d*	-	1dmt	1dmt	1dmt	-	-	-	8	ROM
Budapest	BUD	-	-	*	-	1c	1c*	1c*	1c	1c	1c	4B	4B	4B	4BMT	4BMT	4BMT	4BMT	14	HUN
Buenos Aires	BAA	-	-	-	-	-	-	-	-	-	1cm	-	-	-	-	-	-	-	113	ARG
Caggiano		-	-	1bm	1bm	1bm	1bm	1bm	1bm	1bm	1bm	1bmt	1b	1b	-	-	-	-	15	ITA
Calcutta	CAL	1c	1c	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c*	48	IND
Capannoli		-	-	-	-	-	-	-	-	-	-	-	2a	2a	2a*	-	-	-	19	ITA
Cape	CGH	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	75	SAF
Carloforte	CRL	-	-	2am	2am	2amt	2amt	2amt	2amt	2amt	2amt	2amt	2amt	2amt	2a*	2amt	-	-	21	ITA
Cartuja	CRT	-	-	-	3a	3a	3a*	3a*	2b	2b	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	30	SPA
Casamicciola	CSM	-	3amt	3a*	-	-	-	-	-	3a*	3a*	3amt	-	-	-	-	-	-	16	ITA
Catania	CAT	-	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1BMT	1BMT	1BMT	1BMT	1BMT	16	ITA
Catanzaro		-	-	-	3a*	3a	3amt	3amt	3amt	3a*	3amt	3amt	-	-	-	-	-	-	14	ITA
Chacareta	CCA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1dmt	1d*	1d*	113	ARG
Chalkis		-	-	-	1am	1am	1amt	1amt	1amt	1amt	1amt	-	-	-	-	-	-	-	9	GRE
Cheltenham	CLH	-	-	-	-	-	1d	1dm	1d	1d	1d*	1dm	-	-	-	-	-	-	80	USA
Chiavari	CHV	-	-	-	-	-	-	-	-	-	-	2a	2bmt	2bmt	*	2bmt	-	-	22	ITA
Christchurch	CHR	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	1c*	-	-	148	NZL
Claustahl	CLZ	-	-	-	-	-	-	-	-	-	*+	*	*	3BMT	3B*	3BMT	-	-	22	GER
Cleveland	CLE	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	*	-	82	USA
Cocos Is.	CCK	-	-	-	-	-	-	-	-	-	-	-	-	1cm	1c*	1cm	1cm	-	77	-
Coimbra	COI	-	1cm	1c*	1c*	1cm	1c*	-	-	-	-	-	-	-	-	-	-	1c*	33	POR
Colombo	COC	-	-	-	-	-	-	-	1cm	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	52	CEY
Cordova	PIL	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	-	-	1c*	-	-	116	ARG
Cork		-	-	-	-	-	-	-	-	-	-	-	-	-	1cm	1c*	1c*	-	32	IRL
Czernowitz	CRB	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5BMT	5BMT	-	11	RUS
Davos		-	-	-	-	-	-	-	-	*	*	-	-	-	-	-	-	-	20	SWI
De Bilt	DBN	-	-	-	-	-	2dm	-	-	-	5BMT	5BMT	5BMT	5BMT	5BMT	5BMT	5BMT	5BMT	24	HOL
Denver	DEN	-	-	-	-	-	-	-	-	-	-	-	-	5B*	5B*	5B*	5B*	5B*	93	USA
Derbent		-	-	-	-	-	-	1e	1em	1em	1em	1em	1e*	-	-	-	-	-	10	RUS
Disko Is.		-	-	-	-	-	-	-	-	5BMT	5BMT	5BMT	-	-	-	-	-	-	53	-
Domodossola	DMD	-	-	-	-	-	-	-	-	2d	2d	2dmt	2d	2d	2d	2d	-	-	21	ITA
Durlach		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2e	-	-	22	GER
Dyce	ABE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4CMT	4CMT	30	UK
Edinbourgh	EDI	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	30	UK
Egion		-	-	-	-	-	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	1bmt	-	10	GRE
Ekaterinbourg	SVE	-	-	-	-	-	-	-	-	3bm	3b*	3bm	3b*	3b*	5C	5CMT	5CMT	5C*	24	RUS
Eskdalemuir	ESK	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1c*	4C	4CMT	30	UK
Fanning Is.	FAN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1cm	*	-	135	-
Feldberg	FEL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4BMT	4B*	-	22	GER
Ferrara		-	1b	1b	1b	1b*	1b	1b	1b*	1b	1b	1b	1b	1b	-	-	-	-	18	ITA
Fernando Noron.		-	-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1c*	1c*	-	74	BRA
Fiji	SUV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1c	-	-	143	FIJ
Firenze	FIR	-	3amt	3amt	3amt	3amt	3amt	3am	2dm	2dm	2dm	2dmt	2dm	2dm	2d*	2dm	2dm	-	19	ITA
Fiume		-	-	-	-	*	-	*	-	*	-	*	*	3a*	*	-	-	-	17	YUG
Foggia		-	-	-	-	-	-	2d	2d*	2d	2d	2dmt	2d	2d	*	2dm	-	-	15	ITA
Forli		-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	ITA
Frankfurt	FEL	-	-	-	-	-	-	-	-	-	-	-	-	4BMT	4BMT	4BMT	-	-	21	GER
Freiburg		-	-	-	-	-	-	-	-	-	-	-	-	-	2DMT	2DMT	-	-	21	GER
Genova	GEN	-	-	-	-	-	-	-	-	-	-	3amt	3a	3a	3a*	-	-	-	20	ITA
Giaccherino		-	1am	1am	1a	1a	1a	1a	1a*	1d	1d	-	-	-	-	-	-	-	19	ITA
Göttingen	GTT	-	-	-	-	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	*	22	GER
Graz	GRA	-	-	-	-	-	-	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4CMT	4CMT	4CMT	17	AUT
Grenoble	GRN	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	23	FRA
Guilford		-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	27	UK
Hamburg	HAM	-	4cm	4cm	4cm	4cm	4cm	4cm	4CM	4CM	4CM	4CM	4CM	4CMT	4CMT	4CMT+	4CMT+	4CMT+	22	GER
Harput	ELA	-	-	-	-	-	-	-	1em	1em	3DMT	3DMT	-	-	-	-	-	-	3	TUR
Harvard	HRV	-	-	-	-	-	-	-	-	-	-	-	-	4C*	4C*	4C*	4C*	4C*	75	USA
Hazlemere		-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	28	UK
Heidelberg	HEI	-	-	-	-	-	-	3B*	3B*	3B*	3B*	3B*	3B*	3B*	3B*	3B*	3B*	3B*	21	GER
Helgoland	HLG	-	-	-	-	-	-	-	-	*+	*+	*	*	5CMT	5CM	5CM+	*+	-	24	GER
Helwan	HLW	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	10	EGY
Hof	HOF	-	-	-	-	-	-	-	-	-	-	*	*	3AMT	3AMT	3AMT	*	*	20	GER
Hohenheim	HOH	-	-	-	-	-	-	2cm	2cm*	2cmt	2cm*	2cmt	2cmt	5BMT	5BMT	5BMT	5BMT	5BMT	21	GER
Honolulu	HNL	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	119	USA
Innsbruck	INN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4CMT	4CMT	4CMT	19	AUT
Irkutsk	IRK	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	*	*	5CMT	5CMT	5CMT	-	48	RUS
Ischia	CSM	-	1dm	1dm	1dm	1dm	1dm	1dmt	1dmt	1dmt	1dmt	3amt	3amt	3am	3a	3am	-	-	16	ITA
Isernia		-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	ITA
Istanbul	IST	-	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	-	5	TUR
Izmir	IZM	*	*	*	*	*	*	-	-	-	-	-	-	-	-	-	-	-	6	TUR
Jena	JEN	-	-	-	-	-	-	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	-	-	20	GER
Jugwnheim	JUG	-	-	-	-	-	-	-	-	-	-	-	-	4BMT	4BMT	4BMT	4BMT	-	21	GER
Kabansk	KAB	-	-	-	-	1dm	1d*	1dm	1dm	1dm	*	1dm	-	-	-	-	-	-	50	RUS
Kalamata		-	-	-	1bm	-	1bmt	1bmt	1bmt	1bmt	1bmt	-	1bmt	1bmt	-	-	-	-	10	GRE
Kalocsa	KAL	-	-	-	-	-	-	-	-	-	-	2BMT	2BMT	2BMT	2B*	-	-	-	14	HUN
Karlsruhe	KRL	-	-	-	-	-	-	*+	*	*	*	*	*	3BM	3BM	3BMT	*	*	22	GER
Kew	KEW	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c*	1c*	1c*	27	UK
Kodaikanal	KOD	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	57	IND
Koloszvar		-	-	-	-	-	-	-	-	-	-	*	*	*	*	-	-	-	14	HUN
Königsberg		-	-	-	-	-	-	-	-	-	-	-	-	-	5CMT	5CMT	5CMT	-	20	GER
Krakow	KRA	-	-	-	*	1e	1e	1em	1emt	1emt	1emt	1EMT	1EMT	1EMT	1EMT	1EMT	1EMT	1EMT	15	POL
Krasnoyarsk		-	-	-	*	1dm	1dm	1dm	1dm	*	*	*	-	-	-	-	-	-	41	RUS
Kremsmünster	KMR	-	-	4c	4c*	4cm	4c*	4c	4cm	-	-	-	-	-	*	-	-	-	18	KMR
Ksara	KSA	-	-	-	-	-	-	-	-	-	-	-	*	4B*	4B*	4B	4B	-	5	LEB
Laibach	LJU	1c	1cm	1cmt	1cmt	1cmt	1cmt	1cmt	3am	3am	3am	3am	3am	5Bm	5BM	5EMT	5EMT	-	17	YUG
La Paz	LPZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4B	4B	4B	111	BOL
Leipzig	LEI	-	-	-	2Bm	2Bmt	2BMT	2BMT	2BMT	2BMT	2BMT	2BMT	2BMT	2B*	2B*	2B*	-	-	20	GER
Le Mans	LMF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3BMT	-	-	27	FRA
Lemberg	LVV	-	-	4b	4b	4b	*	*	1Cm	*	*	*	1Emt	1Emt	1EMT+	1EMT	1EMT+	1EMT+	12	POL
Lick	MHC	-	-	-	-	-	-	-	-	-	-	-	-	3BMT+	3BMT	3BMT	3BMT	3BMT	101	USA
Lima	LIM	-	-	-	-	-	-	-	-	1cm	1cm	-	-	1cm	-	1c*	-	-	115	PER
Limerick		-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	33	IRL
Makeevka	MKY	-	-	-	-	-	-	-	-	-	-	-	-	5D*	5D	5D	5D	-	9	RUS
Malta		-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c*	1cm	1cm	16	MAL
Manila	MAN	-	-	-	2d*	2d*	-	2d	2dm	2dm	2dm	2dm	2dm	2dm	2d*	2dm	2dm	2dm	78	PHI

		1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	D°	
Marseilles	MAR	-	-	-	-	-	-	-	-	-	-	-	3B•	3B•	3BMT	3BMT	-	3B•	23	FRA
Mauritius	MRI	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	1c•	63	MAU
Mazatlan	MAZ	-	-	-	-	-	-	-	-	-	-	-	-	-	3BMT	3B•	3B•	3B•	108	MEX
Melbourne	MEL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4CMT	4C•	4C•	127	AUS
Merida	MER	-	-	-	-	-	-	-	-	-	-	-	-	-	5CMT	5C•	5C•	5C•	101	MEX
Messina	MES	1b	-	-	-	1bm	1bm	1bm	1bm	1bm	4am	4am	4amt	•	4amt	4amt	-	-	16	ITA
Milano	MIL	-	-	-	-	1a	1a	1a	1a	-	-	1amt	1am	1a	•	1am	-	-	20	ITA
Mileto	MLE	-	-	-	-	-	-	-	-	2e	2e	3amt	3amt	2dm	2d•	2dmt	-	-	15	ITA
Minec	MNE	1a	1am	1am	1a	1a	1a	1a	1a	1a	1a	1amt	1am	1am	1a•	1am	-	-	16	ITA
Monaco	MON	-	-	-	-	-	-	•	-	•	-	-	-	-	-	-	-	-	21	MON
Moncalieri	MNC	-	-	-	-	-	-	-	2e	2em	2em	2amt	2amt	2a	2a	2amt	2a	2a	21	ITA
Montecassino		-	-	-	-	-	-	-	-	-	-	2a	2am	2a	-	2a	2a	-	16	ITA
Münich	MNH	-	-	-	-	-	-	5C•	5C•	5C•	-	5CMT	-	5CMT	5CMT	5CMT	5CMT	-	19	GER
Neuchatel	NEU	-	-	-	-	-	-	-	-	-	-	-	-	2BMT	2B	2B	2B	2B	22	SWI
Nikolaev		2c	2cm	2cm	2cm	2cm	2cm	2cm	2cm	2cm	2c•	2c•	-	-	-	-	-	-	8	RUS
Nördlingen	NRD	-	-	-	-	-	-	-	-	-	-	-	-	4BMT	4BMT	4BMT	•	•	20	GER
Ogyalla	HRB	-	-	-	-	1d	1d	1d	-	1d	1d•	1d	1d	1d	1d	-	-	-	15	HUN
Osaka	OSK	-	-	4cMT	4cMT	4cMT	4cMT	4cMT	4cMT	4cMT	4cMT	4cMT+	4cMT	4cMT	4cMT	4cMT	4cMT	4cMT	76	JAP
Ottawa	OTT	-	-	-	-	-	-	-	-	-	4BMT	4BMT	4BMT	4BMT	4BMT	4CMT	4CMT	4CMT	76	CAN
Padova	PAD	3b	3b•	3bm	3b	3b	3b	3bm	3bm	3bmt	4bmt	4bmt	4bmt	3BMT	3BMT	3B•	3B	3B	18	ITA
Paisley		-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	-	31	UK
Paris	PAR	-	-	-	-	-	-	-	-	-	-	-	5CMT	5CMT	5CMT	5CMT	5C•	-	25	FRA
Pavia	PAV	1a	1amt	1amt	1amt	1amt	1amt	1amt	1amt	1amt	1bmt	1bmt	1b	1b	•	1bmt	•	•	20	ITA
Pavlovsk		-	-	-	m	m	m	-	-	-	-	-	-	-	-	-	-	-	21	RUS
Perth	PER	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	1c•	1c•	103	AUS
Perugia		-	-	-	•	•	•	-	-	-	-	-	-	-	-	-	-	-	18	ITA
Philadelphia	PHI	•	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	USA
Piacenza		-	-	-	-	•	•	-	-	-	-	-	-	-	-	-	-	-	19	ITA
Pic du Midi		-	-	-	-	-	-	-	-	-	-	-	•	-	•	-	-	-	24	FRA
Plauen	PLN	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	-	20	GER
Pola	POL	-	4bm	4bmt	4bmt	4bmt	4bmt	4bmt	4bmt	4bmt	4bmt	4bmt	4bmt	3BM	3BMT	3BMT	3BMT	5CMT	17	YUG
Pompei	PMP	-	-	-	-	-	-	-	-	-	2c	2cmt	2cmt	2cmt	2cmt	2cmt	2c	2c	16	ITA
Portici		1a	1a	1a	1a	1a	•	1a	1a	1a	1a	1amt	-	-	-	-	-	-	16	ITA
Porto Maurizia		-	-	-	-	-	-	-	-	1a	1a	1amt	1a	2c	-	-	-	-	21	ITA
Porto Rico	VQS	-	-	-	-	-	1c	1c	1c	1c	•	1c	-	-	-	-	-	-	86	PRC
Potsdam	POT	-	-	-	5BMT+	5BMT	5BMT	5BMT	5BMT	5BMT	5BMT	5BMT	5B T	5BMT	5BMT	5BMT	5BMT	5BMT	20	GER
Pulkovo	PUL	-	-	-	-	-	-	-	1e•	5E	5E	5E	5EMT	5EMT	5EMT	5EMT	5EMT	5EMT	21	RUS
Puy de Dome	PDD	-	-	-	-	-	-	-	-	-	-	-	3B	3B	-	-	-	-	24	FRA
Quarto Castelo	QCI	3a	3am	3am	3amt	3amt	3amt	3amt	3amt	3amt	2d	2dmt	2dmt	2cmt	•	2cmt	-	-	19	ITA
Quito	QUI	-	-	-	-	-	•	•	•	-	-	-	-	-	-	-	-	-	108	ECU
Reggio	RCI	-	1am	1a	1a	1a	1a	1am	-	-	-	1amt	-	-	-	-	-	-	16	ITA
Reykjavik	REY	-	-	-	-	-	-	-	-	-	-	-	5CMT	5C	5CM	5CMT	5CMT	-	41	ISL
Rio Tinto		-	-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	32	SPA
Riverview	RIV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5DMT	5DMT	5DMT	129	AUS
Rocca di Papa	RDP	1b	3amt	3amt	3amt	3amt	3amt	4am	4am	4am	4am	4amt	4amt	5am	5AMT	5AMT	-	-	17	ITA
Roma	ROM	3a	3am	3am	3amt	3amt	3a	-	-	-	-	2B	2Bmt	2B	•	2BMT	-	-	18	ITA
St Helena		-	-	-	-	-	-	-	-	-	-	-	-	1cm	-	1cm	-	-	67	-
St Louis	SLM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3B	3B•	3B•	87	USA
St Vincent	SVI	-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	-	-	56	CVI
Salo	SAL	-	-	-	-	-	1am	1amt	1amt	1a	1a	1bmt	1bm	1b	1b	1bmt	-	-	19	ITA
San Fernando	SFS	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	1c•	32	SPA
San Luca		-	-	3a	-	-	-	-	-	-	-	3amt	-	-	-	-	-	-	19	ITA
Santa Clara	SCL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	-	-	101	USA
Sarajevo	SAR	-	-	-	-	-	-	4am	4amt	4amt	4amt	4amt	4amt	3BMT	3BMT	3BMT	-	-	14	YUG
Seychelles		-	-	-	-	-	-	-	-	-	-	-	-	1cm	1cm	1cm	-	-	47	SEY
Shemaha	SHE	-	-	-	1c	1cm	1cm	1c	1cm	1cm	1cm	1cm	1c•	1c•	2D•	2D•	2D•	2D•	10	RUS
Shide		1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	1c•	28	UK
Siena	SIE	-	-	3am	3am	3am	3am	3am	3am	3am	3a	3amt	3a	3a	3a	3amt	•	•	18	ITA
Simla	SMI	-	-	-	-	-	-	1dm	1dm	1dm	1dm	•	•	•	•	1dm	1dm	1dm	35	IND
Sitka	SIT	-	-	-	-	-	3d	-	3d•	3d•	-	3d•	-	-	-	-	-	-	84	USA
Sofia	SOF	-	-	-	-	-	-	1dmt	1dmt	1dmt	1dmt	1dmt	1dmt	1dmt	-	-	-	-	10	BUL
Spinea Mestre		-	•	•	-	-	•	•	•	•	•	-	-	-	-	-	-	-	18	ITA
Stonyhurst	STO	-	-	-	-	-	-	-	-	-	-	1ca	1ca	1ca	1ca	1ca	1ca	1ca	29	UK
Strasbourg	STR	-	4cm	4cm	4cm	4cm	4cm	4cmt	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	4BMT	5AMT	5AMT	5AMT	22	FRA
Sydney	SYD	-	-	-	-	-	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	1c•	129	AUS
Tacubaya	TAC	-	-	-	-	•	•	•	•	•	•	•	•	•	•	•	•	•	108	MEX
Taranto	TAR	-	-	-	-	-	-	-	-	-	4a	4amt	4amt	4a	•	4amt	-	-	14	ITA
Tashkent	TAS	-	-	2d	2dm	1cm	1cm	1cm	1cm	1cm	2dm	2dm	2dm	2dm	5DMT	5DMT	5DMT	5D•	26	RUS
Taunus	TNS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4BMT	4BMT	-	21	GER
Tchita	CIT	-	-	-	-	•	1dm	1dm	1dm	1dm	-	-	-	-	-	-	-	-	53	RUS
Temesvar	TIM	-	-	-	-	-	-	3b	•	3b	•	3b	3b	3b	3b	-	-	-	12	ROM
Tiflis	TIF	3a	3a	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	2DM+	5DM	5DMT+	5D•	5D•	5D•	8	RUS
Tokyo	TOK	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	-	1c•	-	-	79	JAP
Torino	TNO	1b	1bm	1b	1b	1b	1b	1b	1b	1b	1b	1bmt	-	-	-	-	-	-	22	ITA
Toronto	TNT	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	•	•	78	CAN
Tortosa	EBR	-	-	-	-	-	-	-	3b	•	3b	•	3b	3b	3b•	-	-	-	27	SPA
Trento	TRE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	•	15	ITA
Trieste	TRI	3b	3bm	3bm	3bm	3bm	3b•	3b•	3bm	3bm	3bm	3bm	3bm	5CMT	5CMT	5CMT	5CMT	5CMT	17	ITA
Trinidad	TRN	-	-	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	-	-	-	1cm	1cm	-	-	88	TRI
Tsingtau	TSN	-	-	-	-	-	-	-	-	-	•+	3BMT	3BMT	3BMT	3BMT	3BMT	-	-	65	CHI
Uccle	UCC	-	-	1c	1c	1c	1cm	1cm	1cm	1cm	1cm+	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	4CMT	25	BEL
Ungvar		-	-	-	-	-	-	-	-	-	-	1d•	1d•	1d•	1d•	-	-	-	13	RUS
Uppsala	UPP	-	-	-	-	-	5Cmt	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	23	SWE
Urbino		-	-	-	-	1a	1am	1amt	1amt	1amt	1amt	1amt	1amt	1amt	-	-	-	-	18	ITA
Venezia	VEN	-	-	-	-	-	-	4amt	4amt	4amt	4amt	4amt	4a	4a	4a	4amt	-	-	18	ITA
Vernyi	AAA	-	-	-	-	-	-	1d•	1d•	1dm	1d•	1d•	-	-	-	-	2D•	2D•	32	RUS
Verona		-	-	-	-	-	-	-	-	-	-	3amt	3a	3a	-	-	-	-	19	ITA
Vesuvio		-	-	-	-	-	-	-	-	-	-	2bmt	•	-	-	-	-	-	16	ITA
Victoria	VIC	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1cm	1c•	1c•	91	
Vienna	VIE	-	-	-	-	-	-	3bmt	3bmt	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	5CMT	16	AUT
Washington		-	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-	80	USA
Wellington	WEL	-	1cm	1cm	1cm	1cm	-	-	-	-	-	-	1cm	1cm	1cm	1cm	-	-	149	NZL
Yurev	TTU	-	-	2d	2dm	2dm	2dm	2dm	2dm	2dm	2d•	2d•	2d•	2d•	-	-	-	-	20	RUS
Zagreb	ZAG	-	-	-	-	-	-	-	3bmt	3bmt	3bmt	5BMT	5BM	5BM	5BM	5BMT	5BMT	5BMT	16	YUG
Zante	ZAN	-	-	-	1a	1a	-	-	-	1amt	1amt	1amt	-	-	-	-	-	-	11	GRE
Zikawei	ZKW	-	-	-	-	-	-	-	1d	1d	1d	5C•	5C•	5C•	5C•	5C•	5C•	5C•	68	CHI
Zurich	ZUR	-	-	-	-	-	-	-	-	-	-	-	-	5A	4AMT	4AMT	-	-	21	SWI
Zurnabad		-	-	-	-	-	-	-	-	-	1dm+	1dm+	1dm	1d•	2D•	2D•	2D•	2D•	7	RUS

Table 2

List of earthquakes in the northeast Mediterranean region, 1899-1915.

Key :

Date marked with an asterisk indicates foreshock or aftershock.

Origin time (O.T.) is given in GMT (hours and minutes).

Geographical coordinates of macroseismic epicentre are defined as the centre of the region that experienced maximum intensity. Asterisked entries are values calculated from instrumental data. Suffix *i* implies epicentre probably associated with intermediate depth focus.

I_0 is the epicentral intensity in the MSK scale. An asterisk shows maximum intensity value observed, not necessarily epicentral. *F* indicates that the shock was felt in one or more places with generally low intensity which cannot be determined.

F shows that the shock was associated with faulting, and *s* with an offshore epicentre. *L* indicates spurious origin, probably associated with landslides.

r_i are the average radii of isoseismal intensity I_i derived from isoseismal lines in km. r_i^* values show average distance to sites of similar intensity. Dashed values show incongruous radii.

N is the number of stations that recorded the event. The sign of + indicates the minimum or an indeterminate number. An asterisk shows that station readings were masked by a distant large earthquake occurring at the same time.

$M_s = M$, *dM* and *n* are the average surface-wave magnitude and its standard deviation computed with station corrections from readings of *n* instruments. When *M* is not followed by *dM* and *n* but the value of M^* for the event is available, *M* is the value of surface-wave magnitude from equation (6). If *dM*, *n* and M^* are not shown for a particular entry, the *M* value given is from macroseismic data and equation (8).

m, *dm* and *n* are the average body-wave magnitude and its standard deviation without station corrections derived from *n* instruments.

M^*, *dM* and *n* are the average surface-wave magnitude derived from undamped Milne seismographs, its standard deviation and the number of stations that supplied amplitude data (eq. (4)).

Q, *S*1, *S*2 and *S*3 indicate that the main shock was preceded and/or followed by smaller shocks for days, weeks and months respectively. An asterisk shows entries for which more information is needed. *L* indicates a local shock of limited extent. *f* marks events whose epicentral region was visited by the authors.

TABLE II

	O.T. (GMT)	Epicentre N° E°	Io		r2	r3	r4	r5	r6	r7	r8	r9	N	M	dM	n	m	dm	n	M*	dM	n	Q
1899																							
Jan 4	0047	40.45-27.50	VII*	s	-	135	-	-	-	-	-	-	2	5.4			-			-			S2
7	-	38.35-38.30	F		-	-	-	-	-	-	-	-	-	-			-			-			•
13	2000	37.57-43.74	F		-	-	-	-	-	-	-	-	-	-			-			-			•
20*	0646	40.45-27.50	VI*	a	-	100	-	-	-	-	-	-	1	5.1			-			-			
21	1400	37.83-28.56	IV*		-	60	-	-	-	-	-	-	-	4.6			-			-			
23	-	38.42-27.15	F		-	-	-	-	-	-	-	-	-	-			-			-			
27	2000	38.13-29.95	V*		-	30*	-	-	-	-	-	-	-	4.0			-			-			
Feb 4	0600	41.44-34.00	V*		-	-	30*	-	-	-	-	-	-	4.6			-			-			
8	-	40.33-42.59	VII		-	-	45	-	-	-	-	-	-	4.9			-			-			•
Mar 1	-	37.61-28.48	VI*		-	45*	-	-	-	-	-	-	-	4.3			-			-			•
15	-	39.82-34.81	F		-	-	-	-	-	-	-	-	-	-			-			-			
16	0215	37.90-32.50	F		-	-	-	-	-	-	-	-	-	-			-			-			•
20	-	36.90-28.47	IV*		-	30*	-	-	-	-	-	-	-	4.0			-			-			•
29	1600	39.92-27.29	V*		-	-	-	-	-	-	-	-	-	-			-			-			
Apr 9	1000	40.18-29.06	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
16	-	38.40-27.15	F		-	-	-	-	-	-	-	-	-	-			-			-			
May 8	1448	41.80-26.60	F		-	30*	-	-	-	-	-	-	-	4.0			-			-			•
9	-	37.57-43.74	VII*		-	-	-	-	-	-	-	-	-	-			-			-			•
24	1900	40.42-29.15	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
28	2050	41.00-32.80	IV*		-	55*	-	-	-	-	-	-	-	4.5			-			-			•
Jun 8	1400	39.60-27.90	VI*		-	-	-	-	-	-	-	-	-	-			-			-			
Jul 25	-	41.70-26.60	F		-	-	-	-	-	-	-	-	-	-			-			-			S2*
Aug 6*	1800	41.67-26.56	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
13	0200	40.20-37.64	VI*		-	90	-	-	-	-	-	-	-	5.0			-			-			S3
Sep 17*	0300	40.20-37.64	F		-	-	-	-	-	-	-	-	-	-			-			-			
18	1430	40.96-35.66	F		-	-	-	-	-	-	-	-	-	-			-			-			•
20	0212	37.93-28.84	IX	F	-	380	250	160	90	45	30	-	25	6.9			-			6.9(0.2)10			S3f
20*	2000	37.85-28.05	VIII		-	-	-	-	-	-	-	-	-	-			-			-			
22	2100	39.55-28.10	VII		-	90	-	-	15	-	-	-	-	5.1			-			-			S2
23*	0110	37.70-28.30	VIII		-	50*	-	-	10*	-	-	-	-	4.6			-			-			
25*	1600	37.83-28.32	VII		-	110*	-	40*	-	-	-	-	-	5.3			-			-			
26*	-	39.55-28.10	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
27*	0300	37.83-27.51	VIII		-	-	-	30*	-	-	-	-	-	5.1			-			-			•
Oct 1*	0500	39.55-28.10	V*		-	75*	-	-	-	-	-	-	-	4.8			-			-			
1*	0800	37.86-27.60	VI*		-	-	-	-	-	-	-	-	-	-			-			-			
3*	0300	37.80-28.50	V*		-	50	-	-	-	-	-	-	-	4.4			-			-			
3*	2000	39.55-28.10	IV*		-	100	-	-	-	-	-	-	-	5.1			-			-			•
4	-	36.42-28.28	F		-	-	-	-	-	-	-	-	-	-			-			-			•
5	0600	38.80-29.05	VI*		-	-	-	-	-	-	-	-	-	-			-			-			
12*	0600	37.73-27.78	V*		-	50*	-	-	-	-	-	-	-	4.4			-			-			
16*	2300	37.93-27.44	F		-	20*	-	-	-	-	-	-	-	3.6			-			-			
17*	0630	37.93-27.44	V*		-	30*	-	-	-	-	-	-	-	4.0			-			-			
20	1800	38.40-27.15	F		-	-	-	-	-	-	-	-	-	-			-			-			
24*	1800	37.90-28.95	V*		-	45*	-	-	-	-	-	-	-	4.3			-			-			
Nov 7	1300	40.18-29.06	F		-	-	-	-	-	-	-	-	-	-			-			-			
10*	0100	37.95-27.45	V*		-	60	-	-	-	-	-	-	-	4.6			-			-			
11*	0500	37.95-27.45	V*		-	60	-	-	-	-	-	-	-	4.6			-			-			
15	1800	39.10-26.58	VI*		-	-	-	-	-	-	-	-	-	-			-			-			•
16*	-	37.90-28.65	V*		-	50*	-	-	-	-	-	-	-	4.4			-			-			
17*	-	37.90-28.65	V*		-	50*	-	-	-	-	-	-	-	4.4			-			-			•
18*	0600	37.92-27.49	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
29	1610	40.00-37.35	VI*		-	100	-	-	-	-	-	-	-	5.1			-			-			•
29*	1700	38.00-27.42	VI*		-	25*	-	-	-	-	-	-	-	3.8			-			-			
Dec 3*	1800	38.84-27.59	V*		-	20*	-	-	-	-	-	-	-	3.6			-			-			
12*	-	38.10-29.00	F		-	40*	-	-	-	-	-	-	-	4.2			-			-			
18	0440	40.15-29.98	F		-	-	-	-	-	-	-	-	-	-			-			-			
26	2010	39.60-26.45	VII*		210	100	-	-	20	-	-	-	-	5.2			-			-			
28	0300	40.04-28.40	F		-	-	-	-	-	-	-	-	-	-			-			-			
29*	0030	37.86-27.66	V*		-	20*	-	-	-	-	-	-	-	3.6			-			-			
30	-	38.31-26.77	F		-	-	-	-	-	-	-	-	-	-			-			-			
31	1049	41.60-43.50	VIII		-	330	170	95	50	25	-	-	-	6.4			-			6.4(0.3)7			S3
1900																							
Jan 2*	1800	37.89-27.49	F		-	-	-	-	-	-	-	-	-	-			-			-			
5	0055	34.00-34.00	IV*	a	-	210	-	80	-	-	-	-	-	5.9			-			-			•
9*	-	37.79-27.39	F		-	-	-	-	-	-	-	-	-	-			-			-			
15	1620	36.85-28.26	F		-	-	-	-	-	-	-	-	-	-			-			-			
18*	1530	37.79-28.21	V*		-	50	-	-	-	-	-	-	-	4.4			-			-			
21*	0830	37.87-28.21	V		-	-	-	-	-	-	-	-	-	-			-			-			L
24	0300	39.54-26.14	V*	a	-	-	60*	-	-	-	-	-	-	5.2			-			-			•
27	0230	37.63-37.37	V*		-	-	40*	-	-	-	-	-	-	4.8			-			-			
30*	0100	37.83-27.71	VI		-	-	25	-	-	-	-	-	-	4.4			-			-			
Feb 6	1509	38.12-31.29	VI*		-	140	-	45	-	-	-	-	13	5.7			-			5.7(.-)1			
7	-	40.50-26.60	V*	a	-	45*	-	-	-	-	-	-	-	4.3			-			-			•
10*	0500	37.88-27.75	VI		-	-	15*	-	-	-	-	-	-	4.0			-			-			
10	2200	38.35-28.53	IV*		-	-	-	-	-	-	-	-	-	-			-			-			L
14	0015	40.84-31.17	IV*		-	-	-	-	-	-	-	-	-	-			-			-			L
19	0030	39.46-44.00	VII		-	80*	-	-	10	-	-	-	-	4.8			-			-			S2
21*	2300	39.46-44.00	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
23*	0900	39.46-44.00	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
24	0030	38.45-44.87	VI*		-	120*	-	-	-	-	-	-	-	5.2			-			-			•
26	2215	38.21-39.39	F		-	-	-	-	-	-	-	-	-	-			-			-			L
Mar 3	1041	35.00-33.80	V*		-	80*	-	-	-	-	-	-	1	4.8			-			-			•
4	1300	38.68-29.40	F		-	-	-	-	-	-	-	-	-	-			-			-			L
14	1400	38.71-39.26	-	L	-	-	-	-	-	-	-	-	-	-			-			-			
14	1500	38.22-27.64	IV*		-	-	-	-	-	-	-	-	-	-			-			-			LS1
15*	0230	38.50-44.97	VIII		-	90	-	-	-	8	-	-	-	5.1			-			-			f
23	2030	38.31-26.77	IV*		-	-	-	-	-	-	-	-	-	-			-			-			
25	1730	35.82-36.31	F		-	-	-	-	-	-	-	-	-	-			-			-			L
31*	0000	37.95-27.80	VI		-	15*	-	-	-	-	-	-	-	3.4			-			-			
Apr 3	2130	37.75-30.60	V*		-	-	-	-	-	-	-	-	-	-			-			-			S1
4	1220	40.69-36.61	F		-	-	-	-	-	-	-	-	-	-			-			-			L
4	1800	38.26-30.22	F		-	25*	-	-	-	-	-	-	-	3.8			-			-			
10	1953	39.85-27.36	IV*		-	70*	-	-	-	-	-	-	-	4.7			-			-			
10*	-	37.85-27.75	V*		-	20*	-	-	-	-	-	-	-	3.6			-			-			
17*	1900	37.89-27.49	V		-	-	-	-	-	-	-	-	-	-			-			-			L
18*	0000	37.85-29.50	IV*		-	50*	-	-	-	-	-	-	-	4.4			-			-			
23	2030	36.33-33.41	V*		-	-	-	-	-	-	-	-	-	-			-			-			LS1
Apr 26	1045	39.82-34.81	V*		-	-	-	-	-	-	-	-	-	-			-			-			S1
27*	2345	39.82-34.81	F		-	-	-	-	-	-	-	-	-	-			-			-			
May 15*	1830	38.30-29.72	IV*		-	-	-	-	-	-	-	-	-	-			-			-			L
16	0950	39.80-30.30	VI		-	55*	-	20*	-	-	-	-	-	4.7			-			-			LS3*
17*	0830	39.80-30.30	V*		-	-	-	-	-	-	-	-	-	-			-			-			
17	1700	41.07-39.08	F		-	-	-	-	-	-	-	-	-	-			-			-			•
19	1930	41.13-37.30	IV*		-	-	-	-	-	-	-	-	-	-			-			-			•
20	1730	38.36-42.11	F		-	-	-	-	-	-	-	-	-	-			-			-			L
22	2100	38.30-27.65	V*		-	35*	-	-	-	-	-	-	-	4.1			-			-			S1
24*	2315	37.86-28.66	V*		-	35	-	-	-	-	-	-	-	4.1			-			-			
25	1630	36.44-43.35	VII		-	-	30*	-	-	-	-	-	-	4.6			-			-			•
26	1800	37.03-27.45	F		-	-	-	-	-	-	-	-	-	-			-			-			
27	1010	38.44-34.67	V*		-	45*	-	-	-	-	-	-	-	4.3			-			-			•
Jun 1	1600	37.90-28.74	F		-	30*	-	-	-	-	-	-	-	4.0			-			-			
2	2100	41.07-39.08	V*		-	-	-	-	-	-	-	-	-	-			-			-			•
5	1520	38.06-27.74	F		-	-	-	-	-	-	-	-	-	-			-			-			S1
9	0550	38.21-37.20	F		-	-	-	-	-	-	-	-	-	-			-			-			
14	1130	37.85-27.59	F		-	15*	-	-	-	-	-	-	-	3.4			-			-			
15	-	38.40-27.15	F		-	-	-	-	-	-	-	-	-	-			-			-			L
17	0300	38.21-37.20	F		-	-	-	-	-	-	-	-	-	-			-			-			
18	1740	40.43-29.26	VI*		-	75	40	-	-	-	-	-	-	4.8			-			-			S1
20	2100	38.42-27.15	IV		-	-	-	-	-	-	-	-	-	-			-			-			LS1
23	2355	39.77-29.26	F		-	-	-	-	-	-	-	-	-	-			-			-			L
24	0515	40.23-28.05	F		-	-	-	-	-	-	-	-	-	-			-			-			
25*	1600	40.20-29.10	F		-	-	-	-	-	-	-	-	-	-			-			-			
27	-	38.89-40.49	F		-	-	-	-	-	-	-	-	-	-			-			-			•
-	-	37.08-28.42	F		-	20*	-	-	-	-	-	-	-	3.6			-			-			•
-	-	38.49-43.37	F		-	-	-	-	-	-	-	-	-	-			-			-			•
Jul 6*	0533	39.77-29.26	F		-	-	-	-	-	-	-	-	-	-			-			-			
11	1730	37.85-38.66	IV*		-	-	-	-	-	-	-	-	-	-			-			-			L
11	1945	41.00-28.95	IV*		-	-	-	-	-	-	-	-	-	-			-			-			L
12	0205	40.50-26.30	V*	a	-	40*	-	-	-	-	-	-	-	4.2			-			-			
12	0625	40.28-43.06	VIII		-	200	130	-	35	-	-	-	+	5.9			-			-			S2
13	-	39.02-31.15	F		-	-	-	-	-	-	-	-	-	-			-			-			L
16	0600	39.34-26.65	IV*		-	55*	-	-	-	-	-	-	-	4.5			-			-			S2
18	1600	40.30-37.85	V*		-	-	-	-	-	-	-	-	-	-			-			-			LS1
19*	0600	39.10-26.58	F		-	-	-	-	-	-	-	-	-	-			-			-			

			I_o	r2	r3	r4	r5	r6	r7	r8	r9	N	M	dM	n	m	dm	n	M•	dM	n	Q
1900																						
Jul 21•	0600	40.30-37.85	F	-	-	-	-	-	-	-	-	-	-			-			-			
28	1200	38.64-38.24	V•	-	35•	-	-	-	-	-	-	-	4.1			-			-			
Aug 1	0840	40.44-30.10	V•	-	65•	-	-	-	-	-	-	-	4.7			-			-			S1
1	1800	39.10-26.58	F	-	-	-	-	-	-	-	-	-	-			-			-			
4	1134	39.85-27.36	V•	-	50•	-	-	-	-	-	-	-	4.4			-			-			L
6	1325	40.30-36.40	VII+	-	80	-	-	-	7	-	-	-	4.9			-			-			S1
9•	0815	40.44-30.10	IV	-	40•	-	-	-	-	-	-	-	4.2			-			-			
11	0957	39.59-30.24	IV•	-	30•	-	-	-	-	-	-	-	4.0			-			-			L•
13	0025	40.65-39.15	F	-	55•	-	-	-	-	-	-	-	4.5			-			-			•
18•	0000	37.75-28.35	VI	-	40	-	-	-	-	-	-	-	4.2			-			-			
18	1500	39.03-43.36	F	-	-	-	-	-	-	-	-	-	-			-			-			
25	-	40.56-34.96	F	-	-	-	-	-	-	-	-	-	-			-			-			L
Sep 5	0730	38.06-27.74	F	-	-	-	-	-	-	-	-	-	-			-			-			L
6•	1200	40.63-30.56	F	-	-	-	-	-	-	-	-	-	-			-			-			L
7	0445	40.63-30.56	IV•	-	30•	-	-	-	-	-	-	-	4.0			-			-			LS1
9	0600	40.50-29.32	IV	-	-	-	-	-	-	-	-	-	-			-			-			L
9	1220	40.73-26.10	F	-	-	-	-	-	-	-	-	-	-			-			-			
11	2230	40.82-42.12	VII	-	100	-	-	-	-	-	-	+	5.1			-			-			•
12	2245	38.42-27.17	IV	-	-	-	-	-	-	-	-	-	-			-			-			L
18	2030	41.07-37.60	IV•	-	-	25•	-	-	-	-	-	-	4.4			-			-			•
23	-	40.49-29.31	F	-	-	-	-	-	-	-	-	-	-			-			-			L
23	2219	40.27-38.00	VI+	-	45•	-	15•	-	-	-	-	-	4.4			-			-			S1
Oct 5	1700	37.47-44.74	IV•	-	120•	-	-	-	-	-	-	+	5.2			-			-			
10	0841	38.80-29.40	VIII	-	150	-	-	-	15	-	-	1+	5.6			-			-			S1
13	1930	36.73-29.92	V•	-	-	-	-	-	-	-	-	-	-			-			-			L
16•	1730	38.80-29.40	V•	-	80•	-	-	-	-	-	-	-	4.8			-			-			
21	0730	40.73-31.62	F	-	-	-	-	-	-	-	-	-	-			-			-			S1
29	2400	38.05-27.55	V•	-	75	-	-	-	-	-	-	-	4.8			-			-			
Nov 10	1623	38.08-38.72	VI•	-	140	-	45	-	-	-	-	5	5.4			-			-			•
16	1830	38.75-34.62	VI	-	-	-	-	-	-	-	-	-	-			-			-			•
25	1700	38.10-36.65	F	-	70•	-	-	-	-	-	-	-	4.7			-			-			•
27	-	37.95-28.73	F	-	-	-	-	-	-	-	-	-	-			-			-			L
28•	-	37.92-28.92	F	-	-	-	-	-	-	-	-	-	-			-			-			
30	0300	37.86-27.59	F	-	-	-	-	-	-	-	-	-	-			-			-			
Dec 2	2130	40.44-28.98	V•	75•	-	-	10•	-	-	-	-	-	4.2			-			-			

			I	r2	r3	r4	r5	r6	r7	r8	r9	N	M	dM	n	m	dm	n	M•	dM	n	Q
1900																						
Dec 10	1300	38.08-27.41	F	-	-	-	-	-	-	-	-	-	-			-			-			
11	1800	39.64-27.88	VI	-	-	-	-	-	-	-	-	-	-			-			-			•
14	1600	37.85-29.80	V•	-	-	-	-	-	-	-	-	-	-			-			-			L
28	2000	40.18-29.06	F	-	-	-	-	-	-	-	-	-	-			-			-			L
30	1900	37.95-27.41	V	-	-	-	10•	-	-	-	-	-	4.2			-			-			L
1901																						
Jan 10	-	38.02-37.13	VI•	-	-	-	50•	20•	-	-	-	+	5.5			-			-			S2•
Feb 9	-	38.65-26.78	V	-	-	-	-	-	-	-	-	-	-			-			-			L
18	1800	38.68-29.40	F	-	-	-	-	-	-	-	-	-	-			-			-			L
21	-	39.64-38.49	VI•	-	-	-	-	-	-	-	-	-	-			-			-			
23	-	37.86-27.69	V•	-	30•	-	-	-	-	-	-	-	4.0			-			-			LS3
25•	-	38.02-37.13	F	-	50•	-	-	-	-	-	-	-	4.4			-			-			
26	1800	40.77-29.92	V•	-	-	-	-	-	-	-	-	-	-			-			-			L
28	1800	36.99-35.30	VII	-	-	-	-	-	-	-	-	-	-			-			-			L•
Mar 31	0711	43.40-28.70	VIII•s	550	330	240	180	-	-	-	-	27	6.4			-			6.4	(0.4)	7	S3
Apr 3	0055	39.85-44.30	V•	-	-	40•	-	-	-	-	-	-	4.8			-			-			
9	1800	40.30-37.85	VI	-	-	-	-	-	-	-	-	-	-			-			-			L
20	1800	40.61-30.32	VI	-	-	-	-	12•	-	-	-	-	4.9			-			-			S1
22	-	37.81-28.85	V•	-	50	-	-	-	-	-	-	-	4.4			-			-			•
27	-	38.37-40.09	F	-	-	-	-	-	-	-	-	-	-			-			-			•
May 1	-	39.75-39.49	IV•	-	-	-	-	-	-	-	-	-	-			-			-			•
12	1032	39.77-30.51	F	-	-	-	-	-	-	-	-	-	-			-			-			
15	-	37.92-28.92	F	-	-	-	-	-	-	-	-	-	-			-			-			
24	0402	35.50-26.50	VI• s	-	180•	-	70•	-	-	-	-	1+	5.8			-			-			•
31	1800	40.18-29.06	F	-	-	-	-	-	-	-	-	-	-			-			-			
Jun 8	1800	39.64-27.88	F	-	-	-	-	-	-	-	-	-	-			-			-			S1
9	0600	40.60-33.62	F	-	-	-	-	-	-	-	-	-	-			-			-			L
11	1730	40.31-37.21	IV•	-	-	55•	-	-	-	-	-	+	5.1			-			-			S1
14	-	38.01-43.09	VI•	-	-	-	-	-	-	-	-	-	-			-			-			•
Jul 10	0345	38.40-26.65	IV•	-	90•	-	-	-	-	-	-	-	5.0			-			-			L
19	-	37.92-28.33	V	-	-	-	-	-	-	-	-	-	-			-			-			L
Aug 8	-	37.79-27.39	IV	-	-	-	-	-	-	-	-	-	-			-			-			L
Sep 7	0800	39.84-28.14	IV•	-	35•	-	-	-	-	-	-	-	4.1			-			-			
14	-	40.45-37.80	IV•	-	60•	-	-	-	-	-	-	-	4.6			-			-			
27	-	35.55-45.44	F	-	-	-	-	-	-	-	-	-	-			-			-			L
Oct 5	0330	38.36-42.11	IV•	-	-	-	-	-	-	-	-	-	-			-			-			L

			I_o	r2	r3	r4	r5	r6	r7	r8	r9	N	M	dM	n	m	dm	n	M•	dM	n	Q
1901																						
Oct 12	1600	41.38-33.77	F	-	-	-	-	-	-	-	-	-	-			-			-			
24	-	37.77-26.98	V•	-	-	-	-	-	-	-	-	-	-			-			-			
Nov 1•	-	39.92-41.28	V•	-	-	-	-	-	-	-	-	-	-			-			-			S1
3	-	38.12-27.35	V•	-	15•	-	-	-	-	-	-	-	3.4			-			-			
4	1320	40.18-29.06	IV•	-	-	-	-	-	-	-	-	-	-			-			-			L
5•	1800	38.55-30.00	IV•	-	-	50•	-	-	-	-	-	+	5.0			-			-			
6	1749	38.54-30.02	V•	200	-	-	50	-	-	-	-	7	5.4			-			-			
8	1018	40.03-41.53	VIII	-	-	-	90	-	20	-	-	18	6.1			-			6.1	(0.2)	7	S3
11•	1200	40.00-41.50	VII	-	150•	-	-	25•	-	-	-	+	5.5			-			-			
17	-	38.55-30.00	IV•	-	50•	-	-	-	-	-	-	-	4.4			-			-			
26	1600	38.37-42.60	F	-	50•	-	-	-	-	-	-	-	4.4			-			-			L
Dec 5	1800	40.42-29.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
18	0351	39.40-26.70	VIII•s	-	200	110	-	40	-	-	-	15	5.9	(-)	1	-			5.8	(0.1)	2	S1
24	1800	40.46-29.24	IV•	-	15•	-	-	-	-	-	-	-	3.4			-			-			L
25	-	37.92-28.92	V•	-	-	-	-	-	-	-	-	-	-			-			-			L
1902																						
Jan 10	1850	38.41-27.51	V•	-	70	-	-	-	-	-	-	-	4.7			-			-			
16•	-	40.59-36.96	F	-	-	-	-	-	-	-	-	-	-			-			-			L
17	1009	35.16-33.36	IV•	-	-	-	-	-	-	-	-	-	-			-			-			L
Feb 3	2200	40.63-36.79	VI•	-	50•	-	-	-	-	-	-	-	4.4			-			-			S2
4•	1000	40.59-36.96	F	-	-	-	-	-	-	-	-	-	-			-			-			
9	1800	37.85-27.25	F	-	-	-	-	-	-	-	-	-	-			-			-			L
Mar 7	1858	40.51-38.09	V•	-	85	-	-	-	-	-	-	2	5.0			-			-			S2•
8	-	40.48-41.01	F	-	-	-	-	-	-	-	-	-	-			-			-			L
9	0746	40.67-33.57	IX	250	150	-	40	-	-	-	-	23	5.5			-			5.6	(0.2)	3	S3
10	1800	39.92-41.28	F	-	-	-	-	-	-	-	-	-	-			-			-			L
11	1800	38.93-29.38	IV•	-	-	25•	-	-	-	-	-	-	4.4			-			-			
Apr 6	1900	40.60-33.60	F	-	-	-	-	-	-	-	-	-	-			-			-			L
19	1500	37.86-27.59	VI	-	-	-	-	-	-	-	-	-	-			-			-			LS2
May 8	2205	40.30-38.80	VI•	-	110•	-	-	-	-	-	-	+	5.2			-			-			S1•
10	1300	37.05-37.38	V•	-	-	-	-	-	-	-	-	-	-			-			-			
26	0421	37.79-31.07	VIII	-	-	110	70	-	-	-	-	18	5.7			-			5.8	(0.2)	4	S1
28•	-	37.80-31.10	VI	-	-	-	-	-	-	-	-	-	-			-			-			
29	-	38.37-27.68	IV•	-	30•	-	-	-	-	-	-	-	4.0			-			-			
Jun 11	0310	40.52-35.30	V•	-	-	-	-	-	-	-	-	-	-			-			-			S1

			I_o	r2	r3	r4	r5	r6	r7	r8	r9	N	M	dM	n	m	dm	n	M•	dM	n	Q
1902																						
Jun 11	2230	41.02-28.97	F	-	-	-	-	-	-	-	-	-	-			-			-			L
14•	-	40.30-37.85	IV•	-	-	-	-	-	-	-	-	-	-			-			-			
12	0039	37.10-38.13	IV•	-	-	30•	-	-	-	-	-	1	4.6			-			-			S1•
13	0735	40.42-37.77	IV•	-	-	15•	-	-	-	-	-	1	4.0			-			-			S1
17	2020	39.92-41.28	IV	-	-	-	-	-	-	-	-	-	-			-			-			L
20	0330	37.71-27.83	V•	150	-	35	-	-	-	-	-	+	4.8			-			-			
25	0122	41.20-35.20	V	-	110	40	-	-	-	-	-	6	5.0			-			-			S1
Jul 12	-	38.80-29.30	F	-	30•	-	-	-	-	-	-	-	4.0			-			-			•
13	1230	40.30-28.75	F	-	30•	-	-	-	-	-	-	-	4.0			-			-			
14•	2317	40.70-27.80	IV• s	-	100•	-	-	-	-	-	-	1+	5.3			-			5.4	(-)	1	
15•	0135	40.70-27.80	V• s	-	130	-	-	-	-	-	-	1+	5.4			-			5.6	(-)	1	
15	0210	40.70-27.80	V• s	-	130	-	-	-	-	-	-	1+	5.5			-			5.6	(-)	1	
29•	-	40.67-33.57	F	-	-	-	-	-	-	-	-	-	-			-			-			•
Sep 18	1903	38.00-30.63	VIII	-	-	-	-	25•	-	-	-	8•	5.5	(-)	1	-			-			S3
22	0230	41.10-32.50	VI•	-	100•	-	-	-	-	-	-	+	5.1			-			-			S2
Oct 18	1600	37.92-28.92	VI	-	-	-	-	-	-	-	-	-	-			-			-			L
27	-	38.36-42.11	F	-	-	-	-	-	-	-	-	-	-			-			-			L
Nov 23	2014	38.28-27.20	VII•	-	-	-	55•	20	-	-	-	10	5.5			-			5.6	(-)	1	S2
23•	2341	38.30-27.00	F	-	15•	-	-	-	-	-	-	-	3.4			-			-			
24	0600	41.10-32.50	IV•	-	40•	-	-	-	-	-	-	-	4.2			-			-			
24	0919	38.30-27.00	IV•	-	15•	-	-	-	-	-	-	-	3.4			-			-			
Dec 4	1950	38.20-27.50	V	-	20•	-	-	-	-	-	-	-	3.6			-			-			
5•	0709	38.40-27.15	V	-	-	-	-	-	-	-	-	-	-			-			-			
5	1800	38.08-36.84	VI•	-	-	-	-	-	-	-	-	-	-			-			-			L•
7•	0707	38.40-27.15	V	-	-	-	-	-	-	-	-	-	-			-			-			
9•	2116	38.40-27.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
10•	1808	38.40-27.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
11•	1018	38.40-27.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
12•	1919	38.40-27.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
14•	0802	38.40-27.15	F	-	-	-	-	-	-	-	-	-	-			-			-			
15•	0101	38.33-27.23	V	-	20•	-	-	-	-	-	-	-	3.6			-			-			
18•	1750	38.00-30.60	V•	-	25•	-	-	-	-	-	-	-	3.8			-			-			
22	0620	40.00-41.10	VII	-	-	-	-	10•	-	-	-	-	4.8			-			-			S1
22	2208	38.00-39.00	V•	-	115	-	-	-	-	-	-	1	5.2			-			-			S1

			I_o	r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1903																
Jan 12	1600	40.69-36.61	V	-	-	-	-	-	-	-	-	-	-	-	-	L
12	1800	41.40-26.80	VI	-	-	-	-	-	-	-	-	-	-	-	-	L
13	2300	38.45-28.20	VII	-	80•	-	-	-	-	-	-	-	4.8	-	-	S1
15•	2200	38.45-28.20	F	-	-	-	-	-	-	-	-	-	-	-	-	
19	1800	37.85-30.43	V•	-	-	30•	-	-	-	-	-	-	4.6	-	-	
28	0708	40.60-43.10	F	-	-	-	-	-	-	-	-	1	4.4	-	4.6(-)1	L
29	2000	40.18-29.06	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Feb 8	2140	38.48-27.43	VI•	-	-	25•	-	-	-	-	-	-	4.4	-	-	S1
11•	0245	38.48-27.43	IV•	-	-	-	-	-	-	-	-	-	-	-	-	
12•	0030	38.48-27.43	IV•	-	-	-	-	-	-	-	-	-	-	-	-	
16	-	40.42-29.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Mar 1	-	39.92-41.28	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
5	-	38.50-39.00	F	-	50•	-	-	-	-	-	-	-	4.4	-	-	S1•
12	1800	39.60-27.00	F	-	-	-	-	-	-	-	-	-	-	-	-	L
13	-	39.91-28.85	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Apr 2	1402	41.33-43.31	IV•	-	-	20•	-	-	-	-	-	1+	4.4	-	4.6(-)1	
2	-	38.62-27.30	F	-	55•	-	-	-	-	-	-	-	4.5	-	-	L•
16	0440	40.55-41.98	F	-	-	-	-	-	-	-	-	-	-	-	-	L
23	-	36.98-35.31	F	-	-	-	-	-	-	-	-	-	-	-	-	•
27	1810	40.90-35.60	IV•	-	35•	-	-	-	-	-	-	-	4.1	-	-	L
28	2339	39.14-42.65	X	-	500	320	-	115	-	45	-	55	7.0(-)1	6.4(-)1	6.6(0.2)10	S3
29•	0216	39.15-42.65	VII	150•	-	-	-	15•	-	-	-	1	4.9	-	5.1(-)1	
29•	0403	39.15-42.65	F	-	-	-	-	-	-	-	-	1	4.9	-	5.1(-)1	
29•	1411	39.15-42.65	F	-	-	-	-	-	-	-	-	2+	5.0(-)1	-	5.3(-)1	
30•	0216	39.15-42.65	F	-	-	-	-	-	-	-	-	1	4.6	-	4.8(-)1	
May 6	1800	40.29-38.43	F	-	-	-	-	-	-	-	-	-	-	-	-	L
7	1709	40.33-42.60	V•	-	-	-	-	-	-	-	-	-	-	-	-	L
19	-	40.74-31.61	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
21•	1900	39.00-42.50	V•	-	40•	-	-	-	-	-	-	-	4.2	-	-	
25•	-	39.15-42.65	VI•	-	-	-	-	-	-	-	-	-	-	-	-	
25	-	40.78-30.40	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
26	0609	40.65-29.00	VI• s	-	170	-	70	-	-	-	-	20	5.9(-)1	-	5.8(0.4)3	S1
28	0358	40.90-42.75	VIII	270	140	-	40	-	-	-	-	12	5.8(-)1	-	5.4(-)1	
30	1400	41.66-34.10	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Jun 10•	1223	39.15-42.65	F	-	-	-	-	-	-	-	-	1	4.2	-	4.4(-)1	
Jul 6	2200	38.18-31.26	VI•	-	-	30•	-	-	-	-	-	-	4.6	-	-	L
8•	0443	41.40-44.50	F	-	-	-	-	-	-	-	-	-	4.2	-	-	
1903																
Jul 8•	1300	39.15-42.65	F	-	-	-	-	-	-	-	-	-	-	-	-	
9	1321	41.10-44.40	VI	-	100	70	35	-	-	-	-	1+	4.9	-	4.9(-)1	
19	1808	35.00-30.00•	F s	500	-	-	-	-	-	-	-	19	5.6(0.3)2	5.9(-)1	5.9(0.3)2	
23•	2247	39.15-42.65	F	150•	-	-	-	-	-	-	-	1+	4.7	-	4.9(-)1	
31	0900	39.82-34.81	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Aug 6•	0349	39.05-42.42	VIII	-	160	-	-	-	-	10	-	28	5.9(0.3)2	6.2(-)1	5.8(0.2)7	
7•	-	39.61-41.93	V•	-	65•	-	-	-	-	-	-	-	4.7	-	-	
13•	0448	38.73-42.18	V•	-	-	-	40•	-	-	-	-	1+	5.2	-	5.3(-)1	
16	-	40.60-33.62	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
23	-	40.42-29.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
27	1446	34.70-33.25	VII•	-	-	50•	-	-	-	-	-	1	4.7	-	4.9(-)1	L•
Sep 12	0930	38.94-33.54	F	-	-	-	-	-	-	-	-	-	-	-	-	L
13	-	39.12-42.38	F	-	15•	-	-	-	-	-	-	-	3.4	-	-	•
20	1101	41.22-33.51	V•	-	90	-	-	-	-	-	-	5	4.9	-	5.0(-)1	S2
24	0225	38.49-27.15	V•	-	-	-	15•	-	-	-	-	-	4.6	-	-	
Oct 7	1112	36.50-36.50	V•	-	80	-	-	-	-	-	-	1	4.9	-	-	L
30	-	39.05-41.70	VI•	-	55•	-	-	-	-	-	-	-	4.5	-	-	L•
31•	-	41.25-33.50	VI•	-	-	30•	-	-	-	-	-	-	4.6	-	-	
Nov 4	0423	39.25-38.64	IV•	-	40•	-	-	-	-	-	-	1	4.2	-	4.4(-)1	S1
15	1800	40.29-38.43	V•	-	-	-	-	-	-	-	-	-	-	-	-	L
18	-	41.70-26.80	VI	-	30•	-	-	-	-	-	-	-	4.0	-	-	•
28•	-	39.25-38.64	V•	-	25•	-	-	-	-	-	-	-	3.8	-	-	•
Dec 31	1056	42.50-41.86	F	-	-	-	-	-	-	-	-	1	-	-	-	
1904																
Jan 1	2200	38.83-38.69	V•	-	90•	-	-	-	-	-	-	-	5.0	-	-	•
17	1620	38.49-43.37	F	-	-	-	-	-	-	-	-	-	-	-	-	L
21	1530	37.21-28.36	V•	-	-	-	-	-	-	-	-	-	-	-	-	L
Feb 2	0200	37.85-27.27	V	-	-	-	-	-	-	-	-	-	-	-	-	L
12	-	38.08-42.85	F	-	-	-	-	-	-	-	-	-	-	-	-	L
16	0349	40.35-38.58	VII	-	100	70	-	17	-	-	-	3+	5.0(-)	-	5.0(-)1	S2
Mar 20	-	39.64-27.88	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Apr 11	-	40.35-38.58	IV•	120•	80•	-	-	-	-	-	-	-	4.8	-	-	
20	1750	37.79-27.39	F	-	-	-	-	-	-	-	-	-	-	-	-	L
21	-	39.50-39.90	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
1904																
May 19•	2027	38.25-27.74	V•	60•	-	-	-	-	-	-	-	-	4.0	-	-	L
19•	2220	38.25-27.74	VI•	110•	55•	-	-	-	-	-	-	-	4.5	-	-	S2
Jun 25	-	37.92-28.92	F	-	-	-	-	-	-	-	-	-	-	-	-	•
Aug 11•	0225	37.65-26.70	IV• s	120•	-	-	-	-	-	-	-	-	4.7	-	-	
11	0556	37.65-26.70	VIII• s	400	-	160	-	-	35	-	-	28	6.2(0.1)3	6.5(0.5)4	5.8(0.3)7	S3
12•	0130	37.65-26.70	IV• s	140•	90•	-	-	-	-	-	-	-	4.9	-	-	
12•	0612	37.65-26.70	IV• s	-	60•	-	-	-	-	-	-	-	4.6	-	-	
12•	1633	37.65-26.70	F s	-	60•	-	-	-	-	-	-	-	4.6	-	-	
13•	0109	37.65-26.70	IV• s	-	60•	-	-	-	-	-	-	-	4.6	-	-	
14•	0000	37.80-27.00	VII	-	-	-	-	-	-	-	-	-	-	-	-	
15•	1230	38.10-27.10	V• s	-	-	30•	-	-	-	-	-	-	4.6	-	-	
18•	2004	37.73-26.93	IX	310•	230•	-	-	-	20	-	-	26	5.8(0.2)2	6.3(0.3)3	5.5(0.2)4	
20•	1045	37.70-26.90	VII	140•	80•	-	-	-	-	-	-	-	4.8	-	-	
23•	1400	38.10-27.10	F	-	-	-	-	-	-	-	-	-	-	-	-	
27	1606	42.00-41.45	VI	-	-	-	-	-	-	-	-	6	4.4	-	4.6(-)1	•
Sep 4	0112	40.24-41.63	VI	-	45•	-	-	-	-	-	-	-	4.3	-	-	L
5•	0635	37.75-26.98	VI	-	75•	-	-	-	-	-	-	-	4.8	-	-	
19	-	40.63-26.88	VI•	-	80	-	-	-	-	-	-	+	4.8	-	-	L•
Oct 3	-	39.67-33.62	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
8•	0215	37.65-26.70	VI• s	-	120•	75•	-	-	-	-	-	1	4.7(-)1	-	-	
10•	1740	37.70-26.80	VII s	-	-	-	-	-	-	-	-	12	6.0(0.2)2	5.9(-)1	5.7(0.2)4	
Nov 1	-	35.53-27.23	F	-	-	-	-	-	-	-	-	-	-	-	-	•
29	-	39.04-38.50	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Dec 6	1400	36.80-27.96	VI•	-	30•	-	-	-	-	-	-	-	4.0	-	-	
6	-	38.77-38.71	IV•	-	60	-	-	-	-	-	-	-	4.6	-	-	L•
9•	-	37.70-26.80	V•	-	-	-	-	-	-	-	-	-	-	-	-	
15	0010	38.40-27.75	IV•	120	50	-	-	-	-	-	-	-	4.5	-	-	
1905																
Jan 12•	-	37.77-26.98	VI	-	-	-	-	-	-	-	-	-	-	-	-	
24	0003	39.01-43.73	IV•	-	65•	-	-	-	-	-	-	+	4.7	-	-	L
25	-	39.64-27.88	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Feb 3	0305	40.17-42.62	F	-	-	-	-	-	-	-	-	-	-	-	-	L
25	-	42.02-35.22	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Mar 1	-	40.15-29.98	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
20	1430	42.00-26.30	V	80	-	-	-	-	-	-	-	1	4.3	-	-	
1905																
Apr 30	1601	38.81-28.52	VIII•	-	200	-	80	45	-	-	-	27+	6.1(0.1)4	6.4(0.2)3	5.8(0.1)5	S2
May 2•	-	38.80-28.50	V•	-	150•	-	-	-	-	-	-	+	5.4	-	-	
15	-	40.50-37.00	F	-	80•	-	-	-	-	-	-	+	4.8	-	-	L•
26	1800	39.75-39.49	F	-	-	-	-	-	-	-	-	-	-	-	-	•
Jun 4•	1600	38.95-28.67	VII	-	-	-	-	10•	-	-	-	+	4.8	-	-	•
11•	-	39.75-39.49	F	-	-	-	-	-	-	-	-	-	-	-	-	•
16	-	40.37-27.98	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Jul 9	2312	41.67-26.56	V	-	-	-	-	-	-	-	-	-	-	-	-	L
14	0023	39.91-30.04	F	-	-	-	-	-	-	-	-	-	-	-	-	L
30	2316	40.25-45.05	V	-	30	-	-	-	-	-	-	1	4.0	-	-	
Sep 2	-	39.15-42.52	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
27	-	38.42-27.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
Oct 5	2257	40.78-30.40	VI	-	-	-	-	-	-	-	-	-	-	-	-	L
13	-	41.67-26.56	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
16	0320	40.17-42.62	V•	-	-	-	-	-	-	-	-	-	-	-	-	S1
17	0710	40.60-43.10	F	-	-	-	-	-	-	-	-	-	-	-	-	L
17	-	38.42-27.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
20•	2130	42.20-40.50	F s	160•	-	-	-	-	-	-	-	+	5.0	-	-	
21	1101	42.20-40.50•	VI• s	-	330	-	140	70	-	-	-	48	6.5(0.3)3	6.8(0.4)6	6.3(0.2)12	S2
21•	1154	42.20-40.50	F s	160•	-	-	-	-	-	-	-	1+	5.0	-	-	
21•	1321	42.20-40.50	V• s	-	200	-	-	-	-	-	-	22	5.8(0.2)4	6.2(0.3)2	5.6(0.2)5	
22	0355	40.60-28.30	V• s	-	200	100	60	-	-	-	-	35	5.9(0.2)4	6.0(0.3)2	5.4(0.1)4	S2
23	1800	39.10-26.58	V•	-	-	-	-	-	-	-	-	-	-	-	-	L
23	1910	40.05-41.95	IV•	-	60•	-	-	-	-	-	-	-	4.6	-	-	L
31	-	38.42-27.15	F	-	-	-	-	-	-	-	-	-	-	-	-	LS1
Nov 18	1400	41.23-26.43	IV•	-	45	-	-	-	-	-	-	-	4.3	-	-	LS1
28	-	39.04-38.50	F	-	-	-	-	-	-	-	-	-	-	-	-	•
Dec 4	0704	38.12-38.63	IX	-	390	280	-	100	50	-	-	62	6.8(0.3)6	6.9(0.3)3	6.5(0.2)17	S3
4•	0940	38.00-38.25	F	-	-	-	-	-	-	-	-	28	5.5(0.4)2	-	5.9(0.3)3	
4•	1219	38.00-38.25	F	-	-	-	-	-	-	-	-	25	5.5(0.3)2	5.9(-)1	5.8(0.2)5	
5•	1701	38.00-38.25	VII	-	-	-	-	-	-	-	-	6+	5.3	-	5.4(0.2)2	
5	1713	36.50-28.50	IV• s	-	-	-	-	-	-	-	-	4+	5.2	-	5.3(0.3)2	•
6	-	35.36-35.92	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
14	-	37.84-29.00	IV•	-	-	10•	-	-	-	-	-	-	3.7	-	-	L
19	-	38.42-39.23	F	-	70	-	-	-	-	-	-	-	4.7	-	-	LS1•
21	1800	38.42-27.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L•
31	2100	39.04-28.66	VI	-	-	-	-	-	-	-	-	-	-	-	-	L

			I$_o$		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1906																	
Jan 15	-	37.92-28.92	VI		-	-	-	-	-	-	-	-	-	-	-	-	L•
18	-	40.73-39.58	F		-	35•	-	-	-	-	-	-	-	4.1	-	-	L•
Feb 7	-	42.02-35.22	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
18	-	36.95-28.68	F		-	-	-	-	-	-	-	-	-	-	-	-	•
Mar 1	-	38.68-29.40	V		-	-	-	-	-	-	-	-	-	-	-	-	L•
2	-	38.85-42.94	V•		-	60•	-	-	-	-	-	-	-	4.6	-	-	•
6	1645	41.53-44.21	V•		-	50•	-	-	-	-	-	-	1	4.4	-	-	L
26	-	39.08-28.98	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L•
Apr 16	0950	41.67-26.56	F		-	-	-	-	-	-	-	-	-	-	-	-	
21	-	38.18-27.35	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
May 1	-	36.85-28.26	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
27	0500	41.02-28.97	F		-	-	-	-	-	-	-	-	-	-	-	-	L
31	-	37.21-28.36	F		-	-	-	-	-	-	-	-	-	-	-	-	•
Jun 1	-	39.19-26.04	VII		-	-	-	20•	-	5	-	-	-	4.8	-	-	L
Aug 22	0646	40.60-43.10	F		-	-	-	-	-	-	-	-	-	-	-	-	L
27	-	41.02-28.97	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
Sep 13	1908	40.60-43.10	V•		-	-	-	-	-	-	-	-	-	-	-	-	
14	0215	38.42-27.15	F		-	-	-	-	-	-	-	-	-	-	-	-	L
17	1400	37.75-29.08	F		-	-	-	-	-	-	-	-	-	-	-	-	L
28	0731	40.28-42.84	VII		130	-	-	30	-	-	-	-	8	4.7	-	4.9(-)1	S1
Oct 20	1609	41.25-44.25	VI•		-	-	100	35	-	-	-	-	23	5.3(0.1)3	-	5.3(0.3)3	S1
20	-	41.38-33.77	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
Nov 1	0254	40.55-41.98	VI		-	-	-	-	-	-	-	-	2	3.7	-	4.0(-)1	L
25	-	36.90-28.47	VI		-	-	-	15•	-	-	-	-	-	4.6	-	-	•
Dec 22	1700	39.90-41.30	V		-	-	-	-	-	-	-	-	-	-	-	-	LS1
1907																	
Jan 18	0058	38.70-39.25	IV		-	-	-	-	-	-	-	-	1	-	-	-	L
22	0113	41.65-41.63	F		-	-	-	-	-	-	-	-	-	-	-	-	L
22	0238	41.50-28.50	V•	s	160•	70•	-	30•	-	-	-	-	13	4.8(0.2)4	-	4.8(-)1	S1
24•	0338	38.64-42.14	IV•		-	-	20•	-	-	-	-	-	2	4.1(-)1	-	-	
Feb 3	1813	38.72-39.27	IV		-	45•	-	-	-	-	-	-	2	4.3	-	-	S1
6	0400	42.22-26.33	F		-	-	-	-	-	-	-	-	-	-	-	-	S3
Mar 10	1652	37.81-28.33	VII•		-	60•	-	-	-	-	-	-	1	4.4	-	4.6(-)1	
28	-	40.49-37.17	VII		-	-	-	20•	-	-	-	-	-	4.8	-	-	L•
29•	0737	38.60-42.00	VIII		-	-	-	-	-	-	-	-	18	5.0(0.4)6	5.9(0.1)2	5.1(-)1	

			I$_o$		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1907																	
Mar 31	1414	38.53-42.16	VIII		-	150•	60•	-	-	-	-	-	31	5.1(0.3)6	-	5.6(0.2)2	S2
Apr 6	0248	39.35-40.35	F		-	-	-	-	-	-	-	-	1	3.5(-)1	-	-	L
15	0030	38.25-27.47	V•		-	70•	30•	-	-	-	-	-	1	4.6	-	-	S1
17	0215	40.72-30.48	V•		125•	-	25•	-	-	-	-	-	-	4.5	-	-	
20	0424	41.00-28.97	F		-	-	-	-	-	-	-	-	1	-	-	-	L
May 14	0829	38.70-39.30	F		-	-	-	-	-	-	-	-	1	-	-	-	L
30	0010	37.77-26.98	F		-	-	-	-	-	-	-	-	-	-	-	-	S1
Jun 3	0644	38.30-43.80	VIII		-	110•	-	30•	-	-	-	-	18	5.0(0.3)6	-	5.3(0.1)3	
10	-	37.80-27.00	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
17	2018	39.64-27.88	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
21	2247	38.45-27.60	VI		-	100•	-	-	-	-	-	-	6	4.7(0.3)2	-	-	S1
22•	1600	38.60-27.90	V•		-	110•	50•	-	-	-	-	-	+	4.5	-	-	
23	1615	39.43-32.51	F		-	-	-	-	-	-	-	-	3	-	-	-	L
25	0009	38.37-26.14	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Jul 18	-	40.08-37.92	IV•		-	50•	-	-	-	-	-	-	-	4.4	-	-	S1•
Sep 5	2300	39.68-44.42	F		-	-	-	-	-	-	-	-	-	-	-	-	L
18	0517	38.42-27.15	V		-	-	-	-	-	-	-	-	-	-	-	-	LS1
Oct 30	1136	40.84-25.87	F		-	-	-	-	-	-	-	-	-	-	-	-	S1
31	0158	39.80-38.00	VI•		160•	-	-	25•	-	-	-	-	1+	5.0	-	-	
31	0350	38.50-28.50	IV•		100•	60•	-	-	-	-	-	-	-	4.5	-	-	
Nov 15	2114	37.83-29.00	VII		-	-	-	-	-	-	-	-	8	5.1	-	5.2(0.3)3	
28	1121	37.47-34.87	VIII		-	-	-	-	-	-	-	-	2+	5.2(-)1	-	-	•
Dec 5	0255	38.70-29.30	F		-	-	-	-	-	-	-	-	1	-	-	-	L
8	0000	40.18-29.06	F		-	-	-	-	-	-	-	-	-	-	-	-	LS1
11•	0600	40.20-29.05	F		-	-	-	-	-	-	-	-	-	-	-	-	
20	-	39.15-27.00	V•		-	45•	-	-	-	-	-	-	+	4.3	-	-	L•
21	1400	38.38-35.49	F		-	-	-	-	-	-	-	-	-	-	-	-	L
1908																	
Jan 2	-	39.64-27.88	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
3	0800	38.42-27.15	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
4	-	38.87-27.36	VI		-	65•	-	-	-	-	-	-	-	4.7	-	-	
13	0931	38.70-39.25	F		-	-	-	-	-	-	-	-	1	-	-	-	L•
15	0325	39.68-44.42	F		-	-	-	-	-	-	-	-	-	-	-	-	
16	-	40.76-33.64	F		-	20•	-	-	-	-	-	-	-	3.6	-	-	L•
26	-	37.75-29.08	F		-	-	-	-	-	-	-	-	-	-	-	-	

			I$_o$		r2	r3	r4	r5	r6	r7	r8	r9	N	M d dM n	m dm n	M• dM n	Q
1908																	
Jan 28	1600	39.32-40.36	F		-	-	-	-	-	-	-	-	-	-	-	-	
28	1659	37.80-27.10	V•	s	100•	70•	-	-	-	-	-	-	1+	4.6	-	-	S1
31	1600	39.90-41.30	IV•		-	-	-	-	-	-	-	-	-	-	-	-	
Feb 1	-	37.55-34.49	VI•		-	-	55•	-	-	-	-	-	+	5.1	-	-	S2•
16•	2157	38.08-27.41	V•		-	30•	15•	-	-	-	-	-	1	4.0	-	-	
21	1536	39.92-41.28	F		-	-	-	-	-	-	-	-	1	-	-	-	L
Mar 8	2000	37.88-28.09	V•		-	-	25•	-	-	-	-	-	-	4.4	-	-	S1
9•	0300	37.90-28.10	IV•		-	25•	-	-	-	-	-	-	-	3.8	-	-	
12•	0215	37.83-27.61	V•		-		20•	-	-	-	-	-	-	4.2	-	-	
12	1932	40.83-33.10	V•		-	90•	-	-	-	-	-	-	1	4.8(-)1	-	-	L
Apr 3	-	37.03-28.31	F		-	20•	-	-	-	-	-	-	-	3.6	-	-	L•
8•	0300	38.14-27.43	IV•		-	45•	-	-	-	-	-	-	-	4.3	-	-	
11	2145	40.00-32.50	VI•		100•	-	30•	-	-	-	-	-	+	4.5	-	-	•
28	1717	38.10-27.78	VI•		150•	55•	-	-	-	-	-	-	13	4.8(0.2)3	-	-	
May 1	-	38.10-42.41	V•		-	-	-	-	-	-	-	-	-	-	-	-	L•
12	-	38.35-38.30	F		-	-	-	-	-	-	-	-	-	-	-	-	•
15	-	36.61-29.11	F		-	-	-	-	-	-	-	-	-	-	-	-	•
Jun 6	1822	39.26-42.50	V•		100•	-	-	-	-	-	-	-	1+	4.2	-	4.4(-)1	•
20	0756	40.95-43.80	V+		-	-	-	-	-	-	-	-	-	-	-	-	LS1
21	-	36.85-28.26	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
23	1415	38.75-26.65	VII•	s	-	120	75	32	-	-	-	-	20	5.1(0.1)6	5.5(0.2)2	5.0(0.1)2	S2
23•	1442	38.75-26.65	F	s	-	-	-	-	-	-	-	-	15	5.0(0.2)5	5.7(-)1	4.6(-)1	
23•	1603	38.75-26.65	F	s	-	-	-	-	-	-	-	-	15	5.0(0.2)6	5.9(-)1	4.7(-)1	
24•	2022	38.75-26.65	F	s	-	-	-	-	-	-	-	-	13	-	-	-	
25•	1132	38.75-26.65	F	s	-	-	-	-	-	-	-	-	14	4.6(-)1	-	4.6(-)1	
28	1312	38.41-29.29	VII		-	80•	-	25•	-	-	-	-	11	4.8(0.1)3	-	4.6(-)1	S1
Jul 1	-	40.56-34.96	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
2	-	38.36-42.11	VI•		-	-	-	-	-	-	-	-	-	-	-	-	L•
3	0142	38.25-28.00	VI+		-	-	-	-	-	-	-	-	14	4.5(0.1)5	-	4.6(-)1	L
7	0950	41.04-26.62	IV•		70•	-	-	-	-	-	-	-	1	4.1(-)1	-	-	•
24	1856	39,68-44.42	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Sep 28	0627	38.35-39.15	VI•		-	-	-	75•	35•	-	-	-	43	6.1(0.1)8	5.9(0.2)4	6.2(0.1)13	S2•
Oct 23	1150	37.84-37.74	F		-	-	-	-	-	-	-	-	-	-	-	-	•
30	1130	38.00-37.30	VI•		-	140•	65•	-	-	-	-	-	31	5.3(0.3)6	5.6(0.2)4	5.3(0.1)3	S2
Nov 1	2304	41.20-43.85	F		-	-	-	-	-	-	-	-	-	-	-	-	L
2•	-	38.00-37.30	F		-	50•	-	-	-	-	-	-	•+	4.4	-	-	

			I$_o$		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1908																	
Nov 3	2314	37.23-37.82	F		-	-	-	-	-	-	-	-	-	-	-	-	•
11	0500	39.90-41.30	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
19	0208	40.83-42.07	F		60•	-	-	-	-	-	-	-	+	4.0	-	-	S1
Dec 10	0439	42.30-43.00	VII		-	-	140'	75'	35'	8'	-	-	11	4.7(-)1	-	4.6(-)1	
12	1742	41.50-44.50	V		-	-	-	30'	-	-	-	-	4	3.2	-	3.2(-)1	
1909																	
Jan 5	-	38.35-28.53	VI+		-	-	-	-	-	-	-	-	-	- -	-	-	L•
18	0630	41.38-33.77	F		-	-	-	-	-	-	-	-	-	- -	-	-	L
19	0456	38.66-26.94	IX		-	180	100	70	-	20	10	-	36	5.8(0.2)8	5.7(0.5)2	5.7(0.2)5	S1
23	1800	37.86-27.25	VIII		-	-	-	-	-	-	-	-	-	- -	-	-	L
27	0020	41.00-28.95	F		-	-	-	-	-	-	-	-	-	- -	-	-	L
Feb 9	1124	40.17-37.76	IX	F	-	330	220	115	65	31	-	-	59	6.3(0.2)10	6.4(0.3)5	6.4(0.1)16	S2f
9•	1438	40.17-37.76	F		-	-	-	-	-	-	-	-	45	5.8(0.1)7	6.3(0.5)2	6.0(0.1)10	
10•	1949	40.17-37.76	F		-	-	-	-	-	-	-	-	40	5.6(0.2)7	6.3(0.3)2	5.9(0.1)10	
14•	2228	42.50-26.50	V		-	-	-	-	-	-	-	-	2	-	-	-	
15•	0123	42.50-26.50	VI		-	100	45	25	6	-	-	-	11	5.0(0.2)3	-	5.5(0.1)3	
15	0934	42.50-26.40	VIII		-	180	-	70	30	11	-	-	44	5.7(0.3)8	6.3(0.2)2	5.5(0.2)11	S1
15•	1407	42.50-26.40	F		-	-	-	-	-	-	-	-	8	-	-	-	
16•	0255	38.60-27.05	VI		-	-	20•	-	-	-	-	-	1	4.8	-	-	
18	0500	41.80-27.00	F		95	-	-	-	-	-	-	-	+	4.4	-	-	L•
19•	1001	40.15-38.00	VI		-	-	-	-	-	-	-	-	17	4.8(0.2)4	-	5.2(0.3)3	
20•	0600	38.65-26.75	VI		-	-	-	-	-	-	-	-	-	-	-	-	
22•	1414	40.21-37.58	VIII		-	190•	-	-	-	25•	-	-	42	5.7(0.2)9	5.9(0.3)5	5.8(0.1)8	
Mar 5	1217	39.37-40.65	VIII		150•	-	-	30•	15•	-	-	-	19	5.0(0.2)6	4.8(-)1	5.1(0.4)2	S1
8•	0412	39.40-40.55	F		-	-	-	-	-	-	-	-	2	3.9(-)1	-	-	
10	1754	38.85-38.85	VI		-	50•	-	-	-	-	-	-	3	4.4(-)1	-	4.4(-)1	L
10	2200	41.67-26.56	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
18	-	40.42-29.15	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
25	1546	41.60-44.00	VI		-	-	-	-	-	-	-	-	4	3.4	-	3.7(-)1	L
Apr 5•	-	40.15-37.80	F		-	50•	-	-	-	-	-	-	-	4.4	-	-	
May 5	0600	39.65-27.85	V		-	-	-	-	-	-	-	-	-	-	-	-	L
20	0730	40.98-39.64	VI+	L	-	-	-	-	-	-	-	-	-	-	-	-	L
Jun 19	1746	40.50-26.15	IV•	s	-	-	50•	-	-	-	-	-	23	5.1(0.3)5	-	5.1(0.2)2	
27	-	38.36-42.11	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Jul 3	1918	41.20-44.00	V•			160'	120'	60'	-	-	-	-	1	4.1(-)1	-	-	L•

			I_o		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1909																	
Aug 14	0300	41.00-28.20	IV•	a	120•	-	-	-	-	-	-	-	+	4.7	-	-	•
Oct 6	0630	37.06-35.71	VI•		-	35	-	-	-	-	-	-	1	4.1	-	-	L•
12	0630	38.70-39.30	F		-	-	-	-	-	-	-	-	1	-	-	-	L
13	1217	38.40-42.10	F		-	-	-	-	-	-	-	-	1	3.5(-)1	-	-	L
29•	1604	40.53-29.54	VII		-	-	-	-	-	-	-	-	35	5.5(0.3)10	5.4(0.1)2	5.5(0.2)6	
29	1738	40.26-29.64	VII•		-	190	100	-	40	-	-	-	41	5.8(0.4)12	5.7(0.5)4	5.8(0.1)11	S1
Nov 3	0045	38.50-43.40	F		-	-	-	-	-	-	-	-	1	3.2(-)1	-	-	L
3	1215	38.07-30.46	F		-	-	-	-	-	-	-	-	-	-	-	-	L
13	0623	38.70-39.30	F		-	-	-	-	-	-	-	-	1	-	-	-	L
19	1703	38.70-41.91	VII		-	-	30•	-	-	-	-	-	1+	4.5(-)1	-	-	•
24	0731	40.30-41.40	V•		-	-	40•	-	-	-	-	-	1+	4.5(-)1	-	-	L
29	1825	38.35-40.00	VI•		-	-	-	20•	-	-	-	-	1+	4.4(-)1	-	-	S1
Dec 2•	1639	40.10-41.25	VI•		-	-	-	-	-	-	-	-	1	4.5(-)1	-	-	
27	-	40.25-29.65	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
1910																	
Jan 22	1600	38.77-27.17	F		-	35•	-	-	-	-	-	-	-	4.1	-	-	L•
25	0154	40.15-44.55	VI•		-	185'	70'	38'	8'	-	-	-	-	4.0(-)3	-	-	•
Mar 8	0225	40.80-44.50	VI		-	105	55•	20•	7•	-	-	-	-	4.9	-	-	
8	0745	39.90-37.80	F		-	-	-	-	-	-	-	-	-	-	-	-	L
18	0530	40.29-38.43	F		-	-	-	-	-	-	-	-	-	-	-	-	S1•
20	-	36.80-34.60	V•		-	-	-	-	-	-	-	-	-	-	-	-	L•
27	2145	40.30-37.85	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Apr 9	1800	39.02-39.72	VII		-	-	-	-	-	-	-	-	-	-	-	-	•
11	0030	39.10-26.60	F		-	-	-	-	-	-	-	-	-	-	-	-	L
19	0300	37.29-36.48	V		-	-	-	-	-	-	-	-	-	-	-	-	L•
20	-	40.14-26.42	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
May 2	-	39.53-38.13	F		-	-	-	-	-	-	-	-	-	-	-	-	L
20	0600	38.80-42.70	F		-	-	-	-	-	-	-	-	-	-	-	-	L
20•	-	40.90-34.60	F		-	-	-	-	-	-	-	-	-	-	-	-	
21•	0746	40.90-34.60	VII		-	120	-	-	-	-	-	-	29	5.2(0.2)7	5.7(0.1)7	5.4(0.2)8	
22	1600	39.10-26.58	F		-	-	-	-	-	-	-	-	-	-	-	-	L
26	0730	38.35-38.30	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Jun 4	0610	38.23-38.83	VI		-	-	-	-	-	-	-	-	-	-	-	-	L
12	2036	35.50-27.00•	-	a	-	-	-	-	-	-	-	-	24	5.1(0.2)5	5.4(0.3)5	5.0(0.1)5	•
25	1926	40.88-34.56	VII•		-	230	180	-	-	25	-	-	59	6.1(0.4)11	6.4(0.2)6	6.4(0.1)16	S3

			I_o		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1910																	
Jul 14•	0235	38.86-27.84	VI		-	50•	-	-	-	-	-	-	-	4.4	-	-	•
27	1451	38.88-27.87	VIII		-	75	-	-	10	-	-	-	9	4.9(0.2)2	-	4.8(-)1	S1
Aug 1	0210	36.42-28.28	V•		-	-	-	-	-	-	-	-	-	-	-	-	
1	2214	40.40-36.90	V•		-	-	-	-	-	-	-	-	15•	5.1(0.5)2	-	5.4(0.3)6	•
5	0230	40.70-34.50	VI•		120•	-	-	-	-	-	-	-	1	4.7	-	-	•
7	2046	37.66-30.01	VII•		210•	100•	-	-	20•	-	-	-	29	5.3(0.2)8	5.1(-)1	5.3(0.2)5	S1•
16•	0130	40.40-36.90	F		-	60•	-	-	-	-	-	-	-	-	-	-	
18	1904	38.60-40.03	VIII		-	100•	-	-	15	-	-	-	4+	5.0	-	5.0(0.1)2	S3•
19•	0319	38.60-40.03	VII		-	-	-	-	-	-	-	-	2+	4.7	-	4.9(-)1	
19	1423	39.96-41.48	VI		-	40•	-	-	-	-	-	-	1+	4.2	-	-	S1
21•	0916	38.60-40.03	F		-	40•	-	-	-	-	-	-	1	4.2	-	-	
21	1611	35.50-27.50•	-	a	-	-	-	-	-	-	-	-	37	5.3(0.2)7	5.7(0.4)5	5.7(0.2)11	•
22•	1800	38.60-40.03	F		-	-	-	-	-	-	-	-	-	-	-	-	
Sep 12•	1230	38.60-40.03	F		-	-	-	-	-	-	-	-	-	-	-	-	
25	0700	38.53-44.95	F		-	-	-	-	-	-	-	-	-	-	-	-	L
27•	2200	38.60-40.03	F		-	-	-	-	-	-	-	-	-	-	-	-	
Oct 1	-	36.32-36.62	V•		-	50•	-	-	-	-	-	-	+	4.4	-	-	L•
5	-	38.74-34.62	V		-	-	-	-	-	-	-	-	-	-	-	-	L•
7•	2030	40.97-35.22	F		-	-	-	-	-	-	-	-	-	-	-	-	
13	2400	40.97-35.22	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L•
14	1830	38.71-39.96	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
30	1120	38.42-27.15	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Nov 5	1250	39.92-41.28	V		-	-	-	-	-	-	-	-	-	-	-	-	L
16	0815	40.24-37.98	F		-	25•	-	-	-	-	-	-	-	3.8	-	-	L
17	0030	38.20-38.88	V•		-	-	-	-	-	-	-	-	-	-	-	-	L
20	-	40.37-27.98	F		-	-	-	-	-	-	-	-	-	-	-	-	S1•
23•	0745	38.71-39.96	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
Dec 13•	0830	40.00-41.50	VI•		-	40•	-	-	-	-	-	-	+	4.2	-	-	
20•	2100	38.71-39.96	F		-	-	-	-	-	-	-	-	-	-	-	-	L
21	0250	38.71-39.96	VI		-	-	-	-	-	-	-	-	-	-	-	-	LS2
25	1830	41.02-34.04	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L•
26	2330	38.36-42.11	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
27•	-	38.71-39.96	F		-	-	-	-	-	-	-	-	-	-	-	-	
31•	1445	38.71-39.96	F		-	-	-	-	-	-	-	-	-	-	-	-	

			I_o		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1911																	
Jan 8	1000	40.29-38.43	VI		-	-	-	-	-	-	-	-	-	-	-	-	L
21	0800	39.20-39.62	V•		-	40•	-	-	-	-	-	-	-	4.2	-	-	L•
22•	0112	38.71-39.96	V		-	-	-	-	-	-	-	-	-	-	-	-	L
23	-	38.23-40.00	VI•		-	-	-	-	-	-	-	-	-	-	-	-	L•
Feb 6	2157	39.92-41.28	F		-	-	-	-	-	-	-	-	1	-	-	-	•
6	2300	38.20-38.88	V•		-	-	-	-	-	-	-	-	-	-	-	-	L•
11	-	40.73-34.48	IV		-	-	-	-	-	-	-	-	-	-	-	-	L•
15	0200	36.42-28.28	F		-	-	-	-	-	-	-	-	-	-	-	-	L
15	2130	40.66-35.84	F		-	-	-	-	-	-	-	-	-	-	-	-	L
19	1200	40.07-33.50	VI	L?	-	-	-	-	-	-	-	-	-	-	-	-	L
21	0046	40.55-41.88	V•		-	-	-	-	-	-	-	-	-	-	-	-	L
21•	1330	38.71-39.96	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Mar 4•	0630	38.70-40.00	F		-	-	-	-	-	-	-	-	-	-	-	-	
11	1915	41.67-26.56	F		-	-	-	-	-	-	-	-	-	-	-	-	L
18	1845	40.70-30.35	IV•		-	30•	-	-	-	-	-	-	-	4.0	-	-	L
24	-	39.20-41.70	VI•		-	35•	-	-	-	-	-	-	-	4.1	-	-	L•
31	1230	41.89-33.00	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Apr 19	2130	38.67-27.00	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
30	2042	36.00-30.00•i	F	a	-	-	-	-	-	-	-	-	41	5.4(0.2)7	6.2(0.5)5	5.2(0.2)4	•
May 13	2325	40.14-26.40	F		-	-	-	-	-	-	-	-	-	-	-	-	L
17	0330	39.90-37.77	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
30	2159	41.35-43.62	V•		-	70	-	-	-	-	-	-	1+	4.7	-	-	L
Jun 8	0700	39.95-44.57	F		-	-	-	-	-	-	-	-	-	-	-	-	L
20	2200	39.58-29.00	F		-	-	-	-	-	-	-	-	-	-	-	-	L
26	2130	38.71-39.96	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
27	1530	40.59-36.96	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Jul 8	2150	41.80-43.40	V		-	-	-	-	-	-	-	-	-	-	-	-	
17	1957	41.60-44.20	VI		-	110•	50•	20	5	-	-	-	+	4.8	-	-	
Aug 12	1730	36.85-28.26	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
13	1010	38.38-38.59	F		-	30•	-	-	-	-	-	-	-	4.0	-	-	LS2
Sep 9•	2130	38.20-38.90	VI+		-	30•	-	-	-	-	-	-	-	4.0	-	-	
Oct 22	0200	39.32-40.36	V		-	-	-	-	-	-	-	-	-	-	-	-	L
30	1800	38.32-43.75	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
Nov 6	-	36.60-37.80	V•		-	70•	-	-	-	-	-	-	+	4.7	-	-	•
11	1800	38.77-42.71	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
13•	0159	36.00-40.70•	F		-	-	-	-	-	-	-	-	7	5.0	-	5.1(0.3)3	•

			I_o		r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M• dM n	Q
1911																	
Nov 13	0322	34.12-36.13	V•		-	50•	-	-	-	-	-	-	2	4.4	-	-	•
14	1356	36.00-40.70•	V•		-	200•	-	-	-	-	-	-	22	5.5(0.3)4	5.8(0.2)2	5.4(0.1)6	•
Dec 7	0500	40.29-38.43	V•		-	-	-	-	-	-	-	-	-	-	-	-	L
9	-	37.75-29.26	VII•		-	-	-	-	-	-	-	-	-	-	-	-	L
10	1800	40.73-31.62	F		-	-	-	-	-	-	-	-	-	-	-	-	L
26	1230	37.90-39.00	V•		-	85	-	-	-	-	-	-	10	4.8(-)1	-	5.1(0.1)3	•
27	-	38.32-43.75	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
30	1800	39.54-43.67	F		-	-	-	-	-	-	-	-	-	-	-	-	L
1912																	
Jan 3	2130	38.46-39.55	V•		-	30•	-	-	-	-	-	-	-	4.0	-	-	S1
21	1600	38.47-40.66	F		-	-	-	-	-	-	-	-	-	-	-	-	S1
Feb 11	0800	38.71-39.96	IV•		-	-	-	-	-	-	-	-	-	-	-	-	L
Mar 15	1800	39.10-39.95	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
17	2330	38.30-27.48	V•		-	-	40•	-	-	-	-	-	-	4.8	-	-	
29	0045	35.55-35.77	VII		-	-	-	-	5•	-	-	-	-	4.3	-	-	L
30	2114	37.46-44.31	VIII		-	80•	-	-	10•	-	-	-	7	5.1	-	5.2(0.1)2	
Apr 15	0430	36.50-36.35	F		-	-	-	-	-	-	-	-	-	-	-	-	L
28	1700	39.32-40.36	F		-	-	-	-	-	-	-	-	-	-	-	-	S1
May -	-	40.18-29.06	F		-	-	-	-	-	-	-	-	-	-	-	-	L•
Jun 23	1105	40.01-41.20	F		-	-	-	-	-	-	-	-	-	-	-	-	L
Jul 9	1945	40.71-41.50	F		-	-	-	-	-	-	-	-	-	-	-	-	L
16	1230	41.02-28.97	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
21	0100	37.65-30.53	IV		-	-	-	-	-	-	-	-	-	-	-	-	S1
Aug 9	0129	40.75-27.20	X		-	-	440	270	175	100	60	25	85	7.4(0.2)23	6.9(0.3)4	7.4(0.3)23	S3
9•	0425	40.75-27.20	F		-	-	-	-	-	-	-	-	8	4.3(-)1	-	-	
10•	0922	40.75-27.20	F		-	-	-	-	-	-	-	-	60	6.2(0.3)12	5.8(0.3)3	6.1(0.2)15	
10•	1830	40.75-27.20	F		-	-	-	-	-	-	-	-	34	5.3(0.2)10	5.3(-)1	5.2(0.1)6	
11•	0719	40.75-27.20	F		-	-	-	-	-	-	-	-	20	4.8(0.1)3	-	5.1(0.2)4	
25	0430	38.65-30.81	VI•		-	-	-	25•	-	-	-	-	-	4.9	-	-	L
30	1730	39.99-41.69	IV		-	-	-	-	-	-	-	-	-	-	-	-	L
Sep 13•	2332	40.70-27.00	IX		-	-	-	-	-	-	-	-	62	6.8(0.2)13	6.1(0.1)3	6.6(0.2)20	
16•	2105	40.70-27.00	VIII		-	-	-	-	-	-	-	-	25	5.2(0.3)11	-	5.0(0.1)3	
Oct 3	1030	41.00-29.00	F		-	-	-	-	-	-	-	-	-	-	-	-	L
12	1949	41.40-43.70	VI•		-	320	160	80	20	-	-	-	24	5.6(0.2)8	5.6(0.0)2	5.6(0.3)8	S1
13	0223	41.50-43.90	VI•		-	-	-	20•	-	-	-	-	5	5.1(-)1	-	5.0(0.1)2	

			I_o	r2	r3	r4	r5	r6	r7	r8	r9	N	M dM n	m dm n	M* dM n	Q
1912																
Oct 21*	0930	40.70-27.08	F	-	-	-	-	-	-	-	-	2	4.4(-)1	-	4.9(-)1	
21*	2339	40.70-27.08	VII	-	100*	-	-	12*	-	-	-	8	5.1(0.4)3	-	-	
Dec 24*	2005	40.59-27.56	IV*	-	-	-	-	-	-	-	-	-	-	-	-	
1913																
Jan 3	-	36.73-29.92	F	-	-	-	-	-	-	-	-	-	-	-	-	S1*
25	0815	41.00-28.97	F	-	-	-	-	-	-	-	-	-	-	-	-	L
27	1939	39.06-41.60	VIII	-	-	100*	-	-	15*	-	-	47	5.6(0.2)9	5.6(-)1	5.5(0.3)9	S1
27	2010	39.56-33.12	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Feb 1	0740	41.16-27.80	F	-	-	-	-	-	-	-	-	-	-	-	-	L
2	0630	38.79-27.87	V*	-	60*	-	-	-	-	-	-	-	4.6	-	-	•
4	2200	39.75-39.49	IV	-	-	-	-	-	-	-	-	-	-	-	-	L
26	2130	40.30-37.85	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Mar 13	0030	39.32-40.36	VI	-	-	-	-	-	-	-	-	-	-	-	-	L*
28	0900	40.97-27.53	F	-	-	-	-	-	-	-	-	-	-	-	-	LS1
29*	0000	40.97-27.53	F	-	-	-	-	-	-	-	-	-	-	-	-	
30*	2330	40.97-27.53	F	-	-	-	-	-	-	-	-	-	-	-	-	
Apr 20	0314	41.50-44.60	VI*	-	200	130	72	25	-	-	-	40	5.6(0.3)7	5.7(0.2)2	5.5(0.2)7	
24	1700	40.80-27.55	V* s	-	75	-	-	-	-	-	-	-	4.8	-	-	S1
May 8	2345	40.05-30.13	VI*	-	90*	35*	-	-	-	-	-	-	4.8	-	-	S1
10	1830	40.42-29.15	VI	-	-	-	-	-	-	-	-	-	-	-	-	L
14	0915	41.67-26.56	F	-	-	-	-	-	-	-	-	-	-	-	-	L*
Aug 16	2120	41.63-28.12	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Nov 4	-	36.60-36.40	F	-	-	-	-	-	-	-	-	-	-	-	-	L*
20	2210	41.02-28.97	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Dec 9	0230	39.40-41.08	V*	-	-	60	-	-	-	-	-	+	5.2	-	-	S1*
27	-	40.50-27.61	IV	-	-	-	-	-	-	-	-	-	-	-	-	
1914																
Jan 20	-	35.50-44.80	V*	-	55*	-	-	-	-	-	-	+	4.5	-	-	•
25	2145	40.48-41.01	VI*	-	-	-	-	-	-	-	-	-	-	-	-	L
31	1045	38.71-39.96	F	-	-	-	-	-	-	-	-	-	-	-	-	S1
Feb 8	0800	37.77-26.98	VI*	-	-	-	-	-	-	-	-	-	-	-	-	L
Mar 5*	1757	38.46-42.15	F	-	-	-	-	-	-	-	-	9+	5.2(0.2)9	6.1(-)1	-	
7	1910	38.46-42.15	VIII	-	-	-	-	-	15	-	-	2+*	5.8(0.1)2	6.1(0.2)2	-	S1*
7*	2200	38.46-42.15	VII	-	-	-	-	-	-	-	-	+*	-	-	-	
1914																
Mar 9	1000	41.05-29.00	F	-	-	-	-	-	-	-	-	-	-	-	-	L
25	-	38.71-39.96	F	-	-	-	-	-	-	-	-	-	-	-	-	L*
Apr 5	1430	40.00-41.70	V*	-	30*	-	-	-	-	-	-	-	4.0	-	-	
May 17	1346	39.15-26.65	V	-	-	-	-	-	-	-	-	2	3.7(0.1)2	-	-	L
18*	1044	39.50-36.50	VI*	-	90	-	-	-	-	-	-	11+	5.0(0.2)9	-	-	
28	1127	39.25-36.00	VII*	-	155	100	-	-	15	-	-	39+	5.6(0.2)12	6.1(-)1	-	S3
Jun 6*	0250	39.25-36.00	F	-	-	-	-	-	-	-	-	-	-	-	-	
Jul 3*	0019	39.20-36.00	F	-	-	-	-	-	-	-	-	7+*	4.7(0.1)5	-	-	•
Aug 3	1800	37.92-28.92	VI	-	-	-	-	-	-	-	-	-	-	-	-	L
11	1339	39.65-43.90	VII	-	-	-	-	30*	12*	-	-	6+	5.4(0.4)5	-	-	S1
21	0851	38.00-31.50	F	-	-	-	-	-	-	-	-	3+	4.7(0.1)3	-	-	L*
24	-	38.37-26.14	F	-	-	-	-	-	-	-	-	-	-	-	-	L*
Sep 29	2245	39.75-39.49	V*	-	-	-	-	-	-	-	-	-		-	-	L
Oct 3	2206	37.82-30.27	IX	-	-	300	-	100	60	40	-	69	7.0(0.3)19	7.3(0.3)4	-	S2
3*	2323	37.80-30.25	-	-	-	-	-	-	-	-	-	1+*	4.8(-)1	-	-	
4*	0022	37.80-30.25	-	-	-	-	-	-	-	-	-	3+*	4.7(0.1)2	-	-	
4*	0207	37.80-30.25	-	-	-	-	-	-	-	-	-	1+*	4.6(-)1	-	-	
4*	1550	37.80-30.25	-	-	-	-	-	-	-	-	-	8+	5.0(0.1)6	-	-	
4*	1620	37.80-30.25	-	-	-	-	-	-	-	-	-	2+	4.6(0.2)2	-	-	
4*	1750	37.80-30.25	-	-	-	-	-	-	-	-	-	1+	4.4(-)1	-	-	
4*	1810	37.80-30.25	-	-	-	-	-	-	-	-	-	4+	4.8(0.1)4	-	-	
4*	1848	37.75-30.45	VII	-	-	-	-	-	-	-	-	10+	5.2(0.2)7	-	-	
4*	2028	37.80-30.25	-	-	-	-	-	-	-	-	-	1+	4.5(-)1	-	-	
5*	1211	37.75-30.45	F	-	-	-	-	-	-	-	-	4+	4.7(0.2)3	-	-	
6*	1230	37.75-30.45	F	-	-	-	-	-	-	-	-	6	4.8(0.3)4	-	-	
8*	1614	37.80-30.25	VI*	-	-	-	-	-	-	-	-	8	4.9(0.1)8	-	-	
10*	1312	37.60-30.06	VII	-	-	-	-	-	-	-	-	8+	5.0(0.2)7	-	-	•
11*	0945	37.60-30.06	VII	-	-	-	-	-	-	-	-	9+	5.1(0.2)7	-	-	•
13*	2038	38.80-30.30	V*	-	-	-	-	-	-	-	-	1+	4.5(-)1	-	-	•
17*	0013	37.80-30.30	F	-	-	-	-	-	-	-	-	6	4.8(0.1)3	-	-	
27	0405	41.02-28.97	IV	-	-	-	-	-	-	-	-	-	-	-	-	L
Nov 1	2153	38.40-45.40*	-	-	-	-	-	-	-	-	-	-	4.2(-)1	-	-	•
1915																
Jan 7	0719	38.30-26.65	V*	-	45*	-	-	-	-	-	-	1+	4.3(-)1	-	-	S1
18*	0003	38.30-26.65	F	50*	-	-	-	-	-	-	-	-	3.8	-	-	
Feb 14	0819	38.50-41.50*	-	-	-	-	-	-	-	-	-	9+	5.5(0.3)8	-	-	•
Feb 28*	1248	38.50-41.50	-	-	-	-	-	-	-	-	-	4+	5.2(0.2)4	-	-	
Mar 22	1730	38.42-27.15	F	-	-	-	-	-	-	-	-	-	-	-	-	L
Apr 1	0542	40.50-44.50	VI*	-	215	125	45	-	-	-	-	4+	5.1(0.3)4	5.6(-)1	-	S1
May 19	0448	38.45-40.25*	-	-	-	-	-	-	-	-	-	29	5.5(0.2)7	-	-	•
Dec 25	0606	39.30-36.15	IV*	-	-	70*	-	-	-	-	-	16+	5.5(0.2)2	-	-	•

Table 3

Station corrections C_i for surface-wave magnitudes.

	This study		Karnik (*)	Iran (**)
	C_i dC n	n_0	C_i	C_i
Aachen	– 0.1(–) 1	5	+ 0.1	–
Athens	+ 0.1(0.3)27	51	+ 0.1	– 0.1
Beograd	– 0.4(0.1) 2	20	– 0.3	0
Berkeley	– 0.1(–) 1	3	0	–
Budapest	+ 0.1(0.2)15	31	+ 0.1	–
Biberach	– 0.2(0.0) 4	5	+ 0.4	–
Cartuja	+ 0.2(0.2) 8	18	+ 0.1	–
Czernowitz	+ 0.1(0.1) 3	7	0	–
De Bilt	– 0.2(0.2)39	67	– 0.2	– 0.1
Gottingen	+ 0.2(0.2)39	71	+ 0.1	+ 0.1
Graz	+ 0.2(0.1) 2	9	+ 0.2	–
Irkutsk	+ 0.2(0.4) 2	12	– 0.1	– 0.3
Harput	– 0.3(0.5)12	18		–
Hohenheim	0 (0.3)11	34	+ 0.4	+ 0.1
Hamburg	– 0.2(0.1)16	41	– 0.2	– 0.3
Jena	– 0.1(–) 1	5	+ 0.1	+ 0.1
Krakow	– 0.1(0.1) 5	12	0	+ 0.1
Königsberg	+ 0.1(–) 1	4	0	–
Leipzig	+ 0.4(0.2)19	24	0	+ 0.1
Ljubljana	– 0.1(0.2) 6	29	+ 0.1	0
Lvov	– 0.1(0.1) 8	12	– 0.2	–
Munchen	+ 0.4(0.3) 2	2	0	–
Osaka	– 0.5(0.6) 2	8	– 0.2	–
Potsdam	– 0.2(0.2)41	95	– 0.2	– 0.1
Pola	+ 0.1(0.3)27	45	+ 0.2	–
Pulkovo	+ 0.1(–) 1	7	+ 0.1	+ 0.1
Ottawa	+ 0.3(–) 1	2	+ 0.2	–
Riverview	– 0.4(–) 1	2	0	–
Strasburg	– 0.1(0.2)30	89	– 0.1	– 0.1
Trieste	+ 0.2(0.3)26	76	+ 0.1	--
Uppsala	+ 0.1(0.2)42	98	+ 0.2	+ 0.2
Uccle	0 (0.3)10	25	0	–
Vienna	0 (0.2)52	121	– 0.2	– 0.1

(*) Karnik (1968).

(**) Ambraseys and Melville (1982).

Table 4

Station corrections C_j for Milne penduli.

Station	This study	Abe (1985)
	C_j dC_j n	C dC n
Adelaide	− 0.25(−) 1	+ 0.07(0.24)18
Ascension	+ 0.34(−) 1	+ 0.02(0.20) 6
Acores	+ 0.07(−) 1	+ 0.27(0.29)15
Baltimore		+ 0.01(0.35)11
Batavia	+ 0.09(0.07) 2	+ 0.14(0.33)16
Beyrouth	+ 0.04(0.37)22	+ 0.12(0.20)23
Bidstone	− 0.03(0.32)31	− 0.11(0.27)41
Bombay	+ 0.09(0.39) 9	+ 0.07(0.29)36
Calcutta	− 0.18(0.34) 6	− 0.07(0.28)30
Cape	− 0.23(0.27)18	+ 0.01(0.34)32
Chacarita (B. Air)		
Christchurch		+ 0.13(0.28)14
Cocos		
Colombo	− 0.02(0.24) 4	+ 0.16(0.24)21
Cordova	+ 0.20(−) 1	+ 0.21(0.26) 8
Cork	− 0.01(0.03) 2	
Edinbourgh	+ 0.12(0.21)28	+ 0.04(0.21)42
Eskdalemuir	− 0.04(0.20) 9	− 0.04(0.27)23
Fern. Noronha	+ 0.10(−) 1	+ 0.02(0.26)10
Guilford	− 0.14(0.40) 6	+ 0.07(0.30)18
Helwan	+ 0.23(0.26)35	+ 0.04(0.22)30
Haslemere	− 0.09(0.28)12	− 0.25(0.23)33
Honolulu	+ 0.31(0.81) 2	− 0.02(0.34)35
Irkutsk	+ 0.04(0.50) 8	+ 0.04(0.28)12
Kew	+ 0.13(0.28)14	− 0.11(0.20)41
Kodaikanal	+ 0.06(0.38) 5	+ 0.18(0.28)36
Lima		+ 0.19(0.27) 7
Malta	− 0.03(0.37)15	− 0.10(0.16)22
Mauritius	+ 0.45(0.42) 3	+ 0.03(0.28)22
Paisley	− 0.01(0.27)19	+ 0.04(0.23)39
Perth	+ 0.34(−) 1	+ 0.11(0.23)21
Rio Tinto (Hue)	+ 0.26(0.14) 3	− 0.15(0.33)13
S. Fernando	− 0.05(0.23)10	− 0.34(0.34)38
Seychelles		− 0.02(0.22) 5
Shide	− 0.16(0.32)37	− 0.30(0.26)36
Stonyhurst	− 0.05(0.20)11	− 0.28(0.24)26
St. Helena		
St. Vincent (C. Vr)		− 0.13(0.33) 6
Sydney	− 0.66(−) 1	+ 0.24(0.24)25
Tiflis	+ 0.14(0.32)25	
Tokyo		+ 0.06(0.30)13
Toronto	+ 0.50(0.49) 3	+ 0.20(0.34)37
Trinidad		+ 0.25(0.22)15
Victoria	+ 0.51(0.40) 4	+ 0.31(0.27)32
Wellington		+ 0.11(0.16) 8
W. Bromwich	− 0.21(0.38) 7	− 0.43(0.27)15

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Contemporary maps used in the study : various sheets of :
1 : 200, 000 pre-1930 maps of Harita Umum Müdürlüğü
1 : 400, 000 early 1900s maps of R. Kiepert's series
1 : 100, 000 1901 map of W. Lynch
19th century Ottoman military maps and small-scale maps for specific areas.