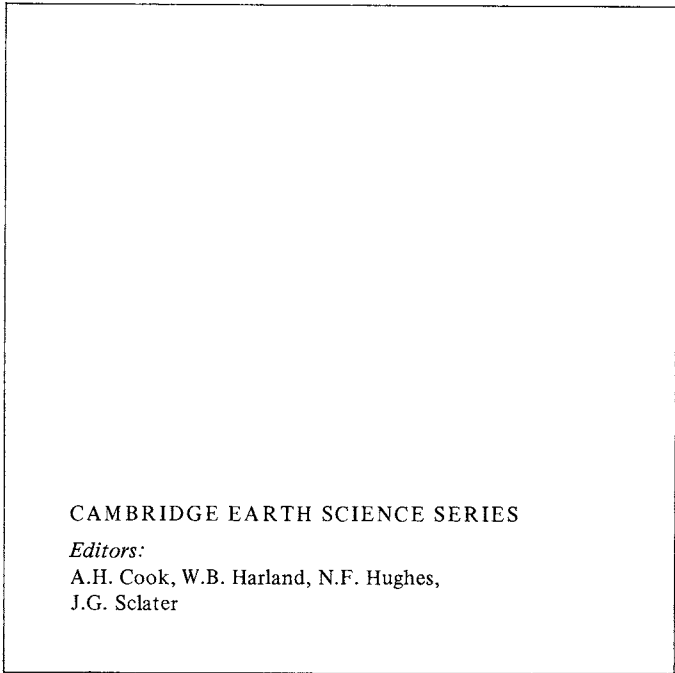


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## Preface

Our choice of title for this book deliberately echoes Davison's *A History of British Earthquakes*, which was published by the Cambridge University Press early in the 1920s. This was one of the first in recent times to make a systematic study of seismic activity in a particular country, which we have tried to emulate for Iran. By calling our study a history we wish also to emphasise the importance of time in the unfolding of geologic processes, and of investigating the past when attempting to understand the present.

It was not clear in advance just how much the study of historical events could lead to a better understanding of the generic cause of earthquakes, the processes of continental deformation, and of earthquake risk. The benefit of being able to refer to observations over a period more than ten times longer than the eighty years that have elapsed of this century, however, was obvious. A striking illustration of the likely value of such historical data, and one that gave a germinal impulse to retrieving them, came simply from comparing two maps of world seismicity. The first (figure 1) was compiled in the mid-1800s by a painstaking solitary scientist, and the second (figure 2) was compiled in the mid-1900s, the result of a multi-million dollar effort by a group of seismologists. Both the similarities and differences between these maps show that the former was anticipatory of later 'discoveries'. Depicted solely on the basis of pre-instrumental, historical data, one can see on the 1857 map almost all the plate boundaries we know today. The data used to construct this map are as crude as the hypothesis or theory of plate tectonics that makes one look for such boundaries. However, on the same map one can also clearly see seismically active regions, such as the Jordan Rift and Eastern Anatolian Thrust zones, as well as Eastern China, these being shown as almost totally inactive on the twentieth-century map.

There is more to be seen in Mallet's map than appears to be there at first sight. In particular, it shows the results of interdisciplinary research that can come to fruition not through the

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agency of a national or international committee for planning or financing research in global tectonics and seismicity (which would probably cause the project to flounder by setting up unimaginative constraints such as a time limit), but by the efforts of dedicated individuals such as Mallet and a few like him, in the days when one had time and was able to read and write in languages other than Fortran.

The need to test observations of short-term seismicity against longer-term trends identified from historical studies has long been recognised and partially fulfilled by previous investigators. If it is easier to criticise rather than praise their efforts, it should be said that they laboured under a disadvantage in that much essential original material was not readily accessible to them. To avoid this drawback, the present study draws on several specialist disciplines to investigate most factors contributing to an identification, assessment and analysis of earthquake data throughout Persian history. The method of interpretation of historical earthquakes in terms of modern concepts evolved gradually in the process of this work, and what is presented here may serve as a starting point for the development of a method of multi-disciplinary study. The fact that we happened to concentrate on Persia, which is not the easiest region available for investigation, is immaterial. Much that emerged should prove relevant to other parts of the world as well.

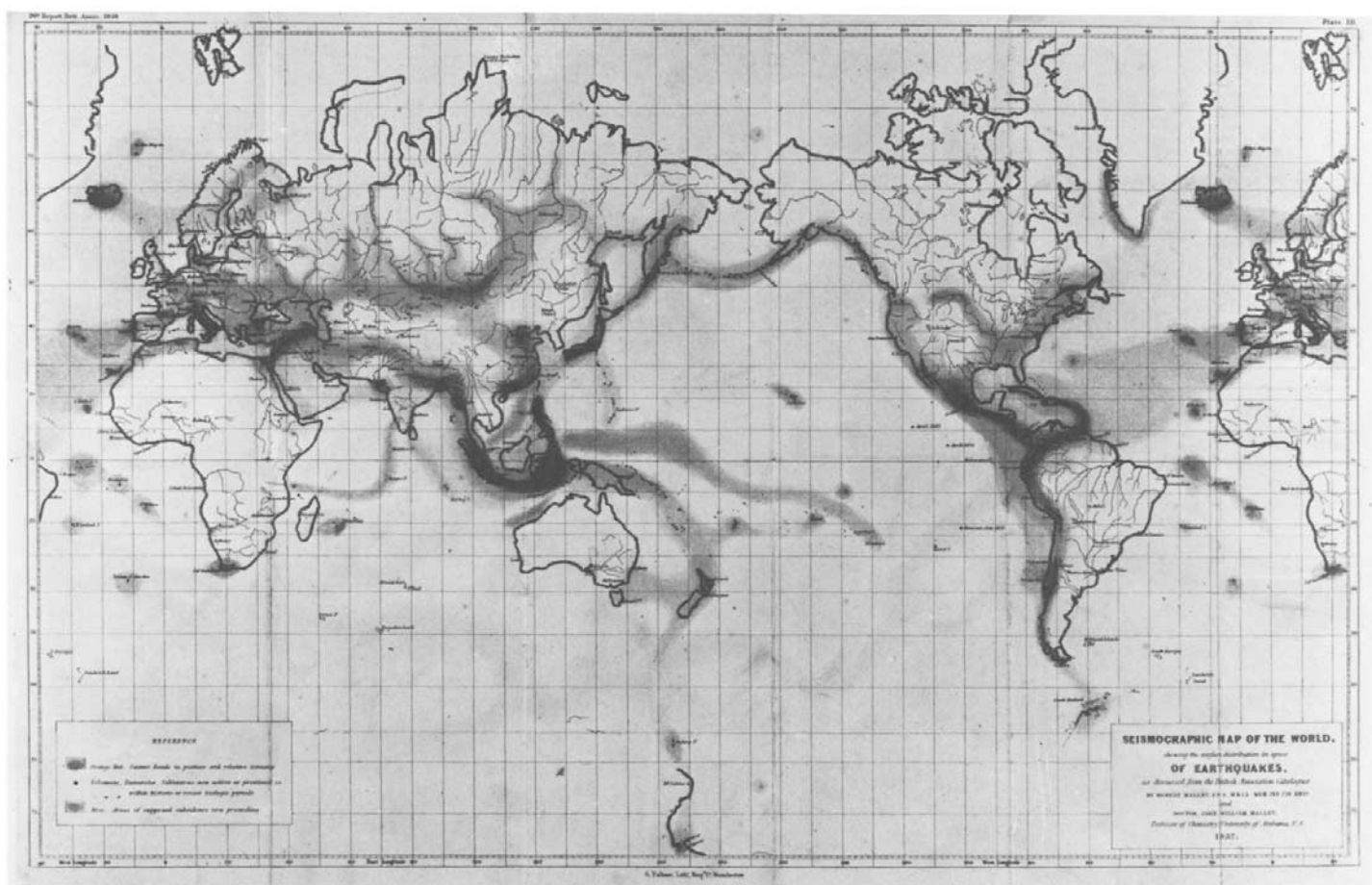
The term 'Persia' is used to underline the scope of our

intentions, for although modern Iran forms our central interest, its present political boundaries were not fixed until the mid-nineteenth century. It is desirable to look beyond these boundaries, not only because it is unrealistic to confine an investigation of geologic processes to such artificial limits, but also because Persia itself once extended far beyond them. The field of Persian history at various times in the past has stretched northwest into Armenia and Georgia (now in Turkey and the USSR), east into Afghanistan and northeast up to the Oxus and the lands beyond Bukhara and Samarqand. These bordering regions thus come within the wider sphere of Iran's historical past and information in varying quantities is available in Arabic, Persian and other oriental sources.

For our present purposes the area thus generally defined as Persia is delineated by the 24th and 40th degrees of north latitude and the 44th and 66th degrees of east longitude (see figure 3, which also shows the physical topography of the region). Selection of this area permits discussion of any events affecting though not originating in Iranian territory, which contribute to the seismicity of the country. It is also determined by the fact that further extension to the west, for which a wealth of data is available, would more than double the volume of an already over-large book; while to the east, the genuine lack of data concerning earthquakes is considered to be significant and therefore needs to be demonstrated.

Although scattered indications of earthquake effects go

Figure 1. Map of the world showing the distribution of earthquakes, prepared by Robert Mallet on the basis of historical data and presented to the British Association in 1857 (28th Report of the British Association, 1858). Note the similarity of this map to the map of short-term, modern seismicity prepared on the basis of modern instrumental data shown in figure 2.





*Preface*

back as far as the third millennium B.C., adequate documentary coverage of individual events does not begin until the advent of the Islamic period in the seventh century A.D. Chapter 1 discusses the various sources that have been found to contain information, and relates their record of events to the prevailing historical circumstances. We can thus form some idea of the completeness of our data, and appreciate how various factors have influenced the distribution of earthquakes recorded prior to the twentieth century.

Non-instrumental, descriptive data (macroseismic data) are retrieved from a variety of documentary materials and also from direct observations made in the field. Chapter 2 deals with the type of information contributed by field studies, which have involved collecting oral or literary data about local earthquakes and also first-hand investigation of regional earthquake effects. This information in turn provides a practical context within which early and modern events should be discussed on a uniform basis. It also permits creation of yardsticks against which they can be classified.

The central chapter presents a description of the largest and most interesting earthquakes that have been identified up to 1979, utilising all the macroseismic data available to us. These accounts illustrate many of the concepts previously outlined. They also form the basis for later theoretical analysis, large magnitude earthquakes being not only the most important from the human point of view, but also the most informative to the earth scientist or earthquake engineer.

Instrumental recordings of earthquakes began around the

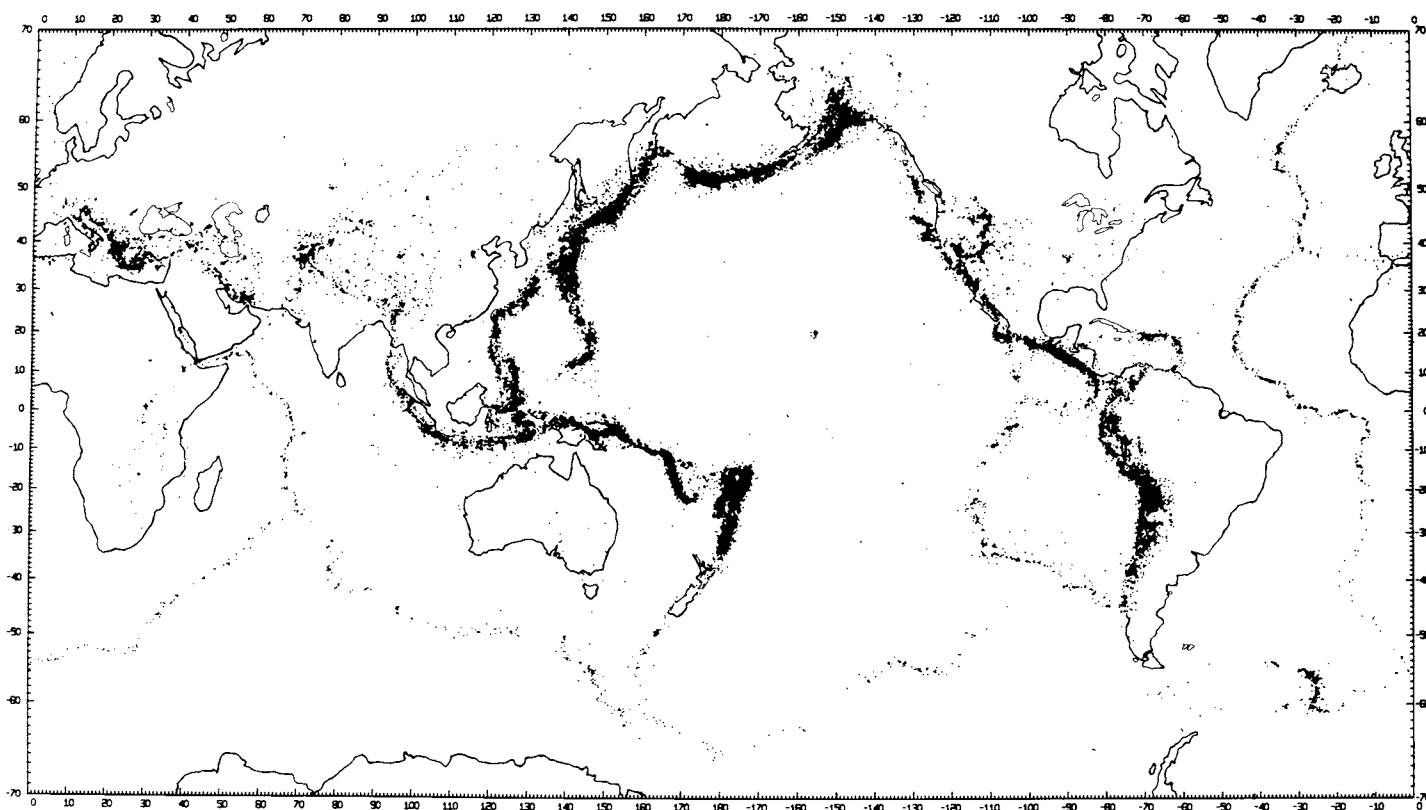
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beginning of the present century, and have subsequently come to yield an accurate supply of precise technical data. Chapter 4 describes the early development of the seismograph network around Persia and the problems caused by deficiencies in the quality of its resources. Early epicentral locations and subsequent attempts at relocation are shown to remain generally inferior compared with those based on macroseismic data. In view of the non-homogeneity of existing magnitudes for earthquakes in Persia before the early 1960s, magnitudes had to be re-calculated uniformly for the whole period. The problem of estimating magnitude values for events for which instrumental data are lacking or inadequate is then examined, and an approach is made to assessing magnitude as a function of other parameters. As these can generally be determined from macroseismic data, it is possible to assign magnitudes to historical events.

In the process of acquiring and classifying this information, a considerable number of new data have emerged. Many hundreds of epicentral locations and magnitudes have been re-calculated or assessed, which, together with other information on damage and Intensities, we intend to publish separately.

The range and type of data assembled allow one to proceed confidently towards an analysis of the seismicity of Persia. This is done largely in terms of the characteristics of earthquake occurrence in certain broadly defined zones that can be identified as coherent units. No attempt is made, however, to use the data for mapping seismic hazard in Iran or for the

Figure 2. Worldwide distribution of instrumentally determined locations of earthquakes for 1961–7. Compare with the figure 1 map, prepared more than a century earlier. (Barazangi & Dorman 1969.)



Preface

preparation of regional vulnerability analysis. This is considered to be the task and responsibility of the relevant Iranian authorities.

One disadvantage of an inter-disciplinary study lies in the demands it makes on its audience. While pursuing a specific goal, it nevertheless draws, sometimes perfunctorily, on the resources of several different fields of learning, and in so doing may satisfy none of them completely, thus falling between however many stools are represented. Most seismologists are not linguists as well; most historians are not also engineers. Examination of earthquakes within their historical context means that many of the data and deductions presented in this work should be of interest to the orientalist, historical geographer or sociologist, as well as to the earth scientist and engineer. The emphasis throughout the book swings from one side to the other. Nevertheless, we hope that an overall balance has been maintained, and we have tried to present the investi-

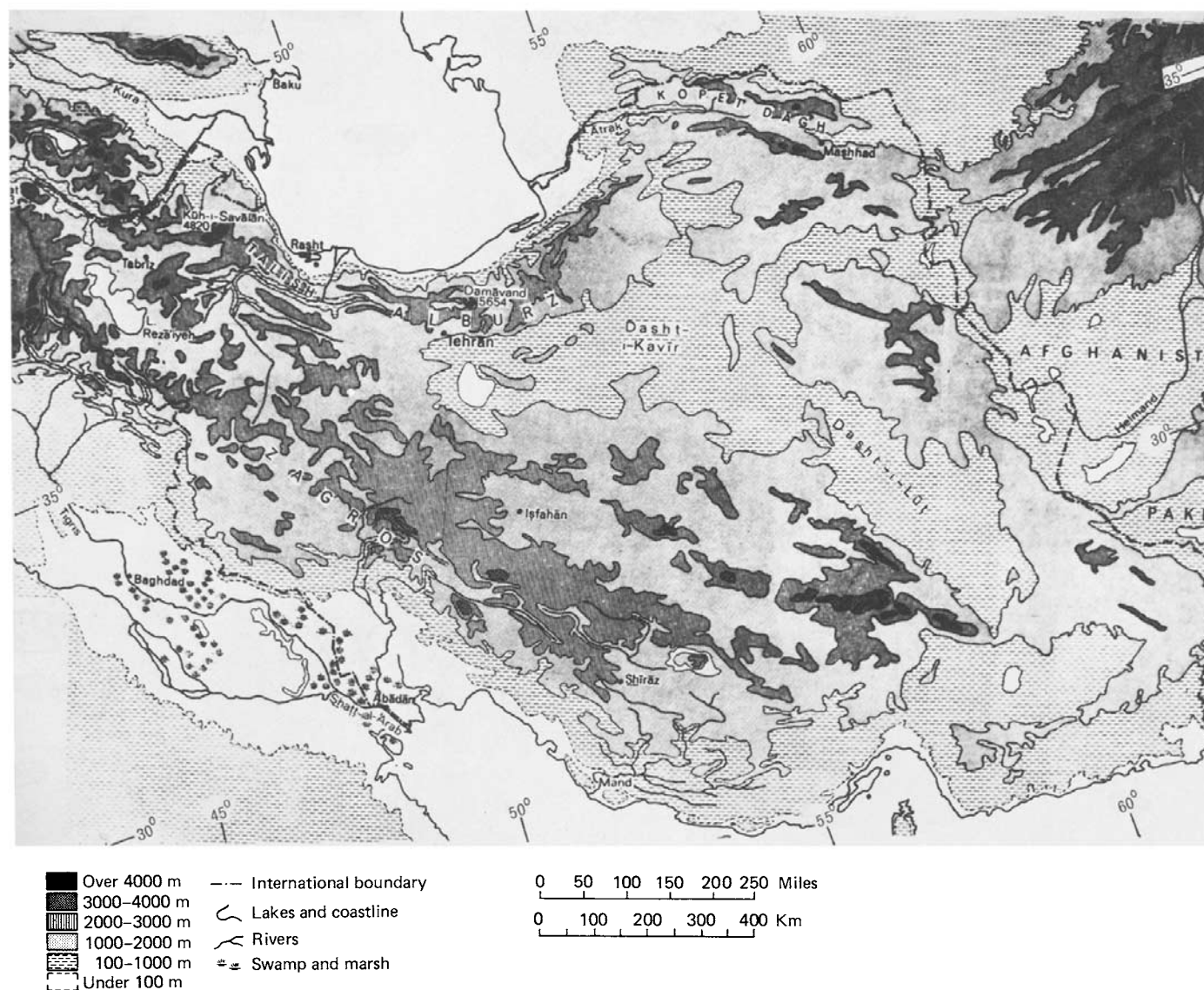
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gation in such a way that contributing facts and ideas are consistently accessible and intelligible to whoever cares to follow them through, given of course a certain initial interest and subsequent concentration. With this in mind, the text has been kept as free as possible from technical jargon, and much that would have over-burdened or distracted attention from the flow of the exposition has found a place in the footnotes, for the length and number of which we make no apology. Even though we have been unable to resolve all the questions to which we hoped this inter-disciplinary study would provide a solution, we nevertheless feel that the curiosity and enthusiasm with which the work was started has produced some rewarding results.

N.N. Ambraseys  
 C.P. Melville

London  
 1981

Figure 3. Physiographical map of Iran (*Camb. Hist. Iran: i* (1968), p. 1).



### Acknowledgements

This work has grown over a period of almost two decades and has owed much to the contribution of individual personalities at various crucial stages. It would be impossible to mention here the names of all the people and institutions that have provided information, facilities, or financial assistance over the years. We hope that anyone who has not been mentioned will not suppose that their help has not been appreciated.

Ali Akbar Moïnfar has done so much to make this work possible during difficult times that he must be mentioned before any other. The late Professor Sedrak Abdalian and Dr Michael Fournier d'Albe were among those whose help in the early stages of this work contributed more than they realised. In the field, invaluable help was provided by John Tchalenko, and by old Iranian students of Imperial College. Also, we would like to thank Jean Vogt, Jean Aubin, Chahriyar Adle and Anne Kroell in Paris for kindly supplying information and also Norman Falcon and Anthony Hughes in London.

For unpublished Arabic manuscripts thanks are due to Abdel Moneim Omar in Cairo, and to Kevork Bardakjian for his great help with Armenian texts. We would like to thank the Soviet Geophysical Committee which, through our late colleague Evgeni Savarenski, provided us with unpublished consular documents. Professors V. Menage and D.J. Wiseman of the London School of Oriental Studies helped with Ottoman Turkish and Sumerian texts, and Pierre Stahl with reliable seismological data during the first stages of the establishment of a seismological service in Iran. Professor Markus Båth, Dr Vit Kárník, Professor David Vere-Jones and Cina Lomnitz read parts of the text and offered very useful advice. We would like to thank Sandy Morton for always being prepared to have his brain picked and for reading through a portion of the typescript.

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We are most grateful for the facilities afforded by many libraries, such as the Royal Geographical Society's library in London, the Millikan Library in Pasadena, the Lenin Library in Moscow, and the Public Record Office in Kew.

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We also wish to thank Clarice Bates for allowing us to use photographs from the album of her father, the late A.D. Hovhannissian of Tabriz.

Lastly, we would like to thank Cambridge University Press, and in particular Alan Cook, for asking us to write this book, and Corinne Gibbons for her help in preparing the manuscript.

### Definitions

*Aftershocks* are secondary shocks following the main earthquake. An *epicentre* is the point on the Earth's surface vertically above the focus, the location in space where the first motion occurs. *Focal depth* is the vertical distance between the focus and the Earth's surface in an earthquake or aftershock. The *focus* is the point within the Earth which marks the origin of an earthquake (hypocentre). *Intensity* is defined by a numerical index describing the effects of an earthquake at a particular location on man, on man-made structures and on the ground itself. The number is rated on the basis of an earthquake Intensity scale, that in common use being the Modified Mercalli Scale of 1931 with grades indicated by Roman numerals from I to XII (Richter 1958: 135, Newmark and Rosenblueth 1971: 217 and Ambraseys 1973). *Isoseismals* are the lines drawn as boundaries between regions of successive Intensity ratings. The adjective *macroseismic* denotes information or data acquired without the help of instruments. The *magnitude* of an earthquake is a measure of the energy released by the shock. Finally, the *meizoseismal* or *epicentral region* of an earthquake is defined as the region of intense shaking in the near-field of the event, usually within the isoseismal of highest Intensity.

### Transliteration

In the course of our research we have had to read books written in a number of languages with a non-Latin script. Transliteration from these languages is normally designed to reproduce the symbols of the original, but this can lead to a text that is daunting to look at and difficult to read. The need for a system of transliteration arises primarily in the case of spelling place names and, to a lesser extent, other proper names.

As a fundamental principle, place names throughout the book are spelt as they are written in the script of the country in which they are located; this generally involves a transliteration. Because of the fluctuating demarcation of boundaries over the long period covered, and because places formerly in Armenia or now in Turkey and Russia were once under Persian administration, it is in practice necessary to refer to places as they were known in the historical context in which they are cited. Their equivalents are given as identified, along with other modern names conforming to their current indigenous spelling. Particularly in the northwest of our area, some names are given a standard spelling, chosen arbitrarily for its familiarity, such as Erivan (for Yerevan) and Tiflis (for Tbilisi).

E.G. Browne once observed that it is both easier and more philosophical to transliterate on a fixed and definite principle than to decide in each case whether a given spelling has or has not been sanctioned by usage. A rigid system for the transliteration of Arabic and Persian has only been followed, however, in the bibliography, where names of authors and titles of books have been given in accordance with the system used in the *Cambridge History of Iran*. Persian variant forms of Arabic consonants are used only if they occur in a place name or personal name. In the body of the text, this system has been greatly relaxed, notably by the omission of macrons and diacritics. This in turn makes a number of consonants indistinguishable from one another, but this is not likely to bother a specialist. Persian variant forms generally approximate

### Transliteration

Persian pronunciation, thus Faizabad (for Arabic Faiḏābād), although the tendency has been to retain the Arabic 'th' throughout (pronounced 's' in Persian). Place names in Iran are spelt consistently on the basis of such a transliteration from the Persian. On the other hand, common Islamic terms such as Ramaḏān or Qāḏī retain their basic Arabic spelling, thus Ramadan, Qadi. The absence of macrons makes long and short vowels also indistinguishable, the vowels 'o' and 'e' generally being avoided, though the latter is invariably used before the Persian 'silent h', which is given as 'eh'. This usage has spilled over into words where the h is not silent, such as Tehran and *deh* (village), the latter being correctly spelt only in the word *dihistan* (village district). Other minor inconsistencies, firmly supported by modern usage, have escaped the pedantic axe, such as the spellings 'Herat', 'Mosul' and 'Melli'. Similarly, it is obviously out of the question to transliterate correctly the names of Iranian authors who themselves spell their names in English at variance with our own system. This last observation applies to all bibliographical references using Latin characters in the original, these merely being reproduced as they stand.

Transliteration from Turkish presents additional problems, thanks to the change from Arabic to Latinised script instituted by Atatürk in 1928. Modern Turkey impinges only marginally on our area, and in deference to the wider geographical and historical scope of the book, Ottoman Turkish, used for the bulk of the period covered, is transliterated effectively as though it were Persian. The system used in the *Red-house Dictionary* (Istanbul 1968), which has both Arabic and

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Latinised characters, is thus not followed where the Arabic or Persian form of names and titles is more familiar. In the absence of diacritics, ç is written 'ch' to distinguish it from c (Persian 'j') and 'sh' and 'kh' are preferred to ş and h, when reproducing both Ottoman and modern Turkish script; thus we have Ja'far for Cafer, Chelebi for Çelebi, shaikh for şeyh, pasha for paşa, *tarik* for *tarih*, etc. Place names in Turkey may thus be modified slightly from spellings found on modern maps, which are used for reference in conjunction with H. Kiepert's map, *Provinces asiatiques de l'Empire Ottoman*, published in 1884, on a scale of 1:1 500 000.

Kiepert's map also provides a reference for place names in Armenia and Georgia. In addition, Armenian place names found in contemporary historical accounts are spelt as in Hübschmann, *Die altarmenischen Ortsnamen* (Strasburg 1904), with an accompanying map. Hübschmann's standard academic transliteration, which uses various Latin characters artificially, is unintelligible to a general reader and names have therefore been transcribed phonetically according to the scheme in Gulbekian, 'A phonetic transcription from Armenian to English', *Ararat: II* (New York, Summer 1961). The same transcription has also been used for personal names.

Russian place names reported in Latin characters are adopted directly from the original text. Names of people and titles of books are similarly reproduced if given originally in Latin script; transliteration from the Cyrillic script follows the system in L.I. Callahan, *Russian-English Technical and Chemical Dictionary* (New York 1961).

### Chronology

Several calendars have been used to date the earthquakes recorded in Persia, notably the Seleucid (Sel.), Armenian (Ar.), Muslim *hijra* (H.) and Persian *shamsi* (Sh.) calendars. Details of these, and others less frequently employed, may be found in V. Grumel, *Traité d'études Byzantines, I: La chronologie* (Paris 1958), which has been used to convert dates to the Christian era.

The Persian solar year begins in March, conversions involving the addition of 621 years to the *shamsi* date for the first nine months of the year and 622 for the last three: thus Farvardin 1350 falls in 1971, but Isfand 1350 in 1972.

The Muslim *hijra* calendar is lunar and began on 16 July, A.D. 622. Conversions are calculated from the tables of H.G. Cattenoz, *Tables de concordance des Ères Chrétienne et Héglirienne* (Rabat 1961). Where a conversion is given, the Muslim year comes first, e.g. 704/1304; the Christian year is the one that forms the longest part of the Muslim year in case of overlap, unless it can be established that the other is more accurate.

Throughout the book, dates are given A.D. unless otherwise indicated, as by one of the suffixes noted above. However, Persian *shamsi* and Muslim *hijra* years are not suffixed when the month is also given. For this reason, the months of the two calendars are set out below, for easy reference and to encourage familiarity with their sequence:



*Chronology*

<i>Persian solar months</i>	<i>Muslim lunar months</i>
1. Farvardin Urdibihisht	1. Muharram Safar
3. Khurdad Tir Murdad	3. Rabi' I Rabi' II Jumada I
6. Shahrivar Mihir Aban	6. Jumada II Rajab Sha'ban
9. Azar Day (Daimah) Bahman	9. Ramadan Shawwal Dhu 'l-Qa'da
12. Isfand	12. Dhu 'l-Hijja

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It should be obvious from the context which calendar is being used, for instance in references to issues of newspapers or other Persian journals.

In England the change from Julian or Old Style to Gregorian or New Style dating took place in September 1752. We should note that use of the Old Style system in some of the European sources consulted, particularly Russian, persists up till as late as the first decade of the twentieth century.