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RE-APPRAISAL OF THE SEISMICITY OF ICELAND

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HÁSKÓLI ÍSLANDS

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ABSTRACT

The objective of the present report is to provide a uniform account of the seismicity of the Icelandic region, defined herein as the area between 62° to 68° N and 12° to 26° W. This account is based on retrieval and assessment of public domain, original sources of information, which are, in the first place, teleseismic data obtained from station bulletins, and, secondly, books, periodicals, newspapers and public domain reports. The station bulletins are utilised for recalculation of surface-wave magnitudes and epicentral locations, whenever possible. The second main source of information forms the basis of case histories relating, at least qualitatively, felt effects and induced damages to the size and proximity of the earthquakes, represented by the re-calculated magnitudes and epicentral location.

The main results are presented in a parametric earthquake catalogue for Iceland. It contains epicentres and recalculated surface-wave magnitudes obtained by uniform data processing. The catalogue covers one century, i.e., from 1896 to 1996. The selection of the starting year for the catalogue reflects the fact that the first earthquake in Iceland for which teleseismic data are available is the destructive 1896 South Iceland Earthquake. The descriptive catalogue dealing with the individual case histories contains isoseismal and meizoseismal maps for the biggest events.

Key words: Seismology, seismicity, earthquake, magnitude, Iceland.

CONTENTS

PREFACE

The present report is a contribution to the history of Icelandic earthquakes. It is the outcome of a long-standing co-operation between the Engineering Seismology and Earthquake Engineering Section at the Imperial College of Science, Technology and Medicine and the Engineering Research Institute at the University of Iceland. A precursor to this joint venture started out in the so-called working group 2 on strong motion studies under the auspices of the European Association of Earthquake Engineering. Our co-operation was formalised in a memorandum of understanding between the Department of Civil Engineering at the Imperial Collage and the Engineering Research Institute in 1994.

Our research on Icelandic earthquakes started out as a small project, which we anticipated would only take us a short time to finish. However, the work turned out to be more extensive than expected and 'the story grew in the telling'.

The work has been carried out without any grants or direct financial backing. We are, however, grateful to our institutes and colleagues for supporting our work.

N. N. Ambraseys
R. Sigbjörnsson

1. INTRODUCTION

The objective of the present study is to provide a uniform account of the seismicity of the Icelandic region, based on retrieval and assessment of original sources of information in the public domain. The study area is defined as the area between 62° and 68° N and 12° and 26° W (see Figure 1.1). The time period spanned by our study covers one century, i.e., from 1896 to 1996. The selection of the starting year for the catalogue reflects the fact that the first earthquake in Iceland for which we have teleseismic data is the destructive 1896 South Iceland Earthquake.

Our main data sources are two: First, teleseismic data obtained from station bulletins, and, second, books, periodicals, newspapers and public domain reports. The station bulletins are utilised for re-calculation of surface-wave magnitudes and epicentral locations, whenever possible. The second main source of information forms the basis of the individual case histories. The purpose of the case histories is to relate, at least qualitatively, felt effects and induced damages to the size and proximity of the earthquakes, represented by the re-calculated magnitudes and epicentral location.

The main results of this study are furnished in a parametric earthquake catalogue for Iceland covering one century, i.e., from 1896 to 1996. It is our hope that the presented catalogue, developed by uniform data processing, is a reliable foundation for risk assessment and risk management required for structural design and, furthermore, for dealing with the infrastructures of modern Icelandic society.

2. INTENSITY

Figure 2.1 shows the population density of Iceland at about the turn of the century. With few exceptions, the population is distributed along the coastline and the lowland areas, shown in green on Figure 1.1.

This low population density makes an assessment of intensity difficult, particularly when we consider that during the first half of the century, the building stock on the island consisted chiefly of only two sorts of one-storey buildings. One, built mostly of timber, was of relatively low vulnerability, and the other, of high vulnerability was in the main constructed of natural stone laid in turf without foundations. The former and better class of dwellings was built in the few existing towns and on larger farms, and the latter, in greater numbers, was used for store-houses and for the housing of animals.

Also the limited land area of the island and the fact that more than half of it was, and still is, uninhabited and the rest sparsely settled, makes it difficult to assess the distribution of intensity, particularly in the far field.

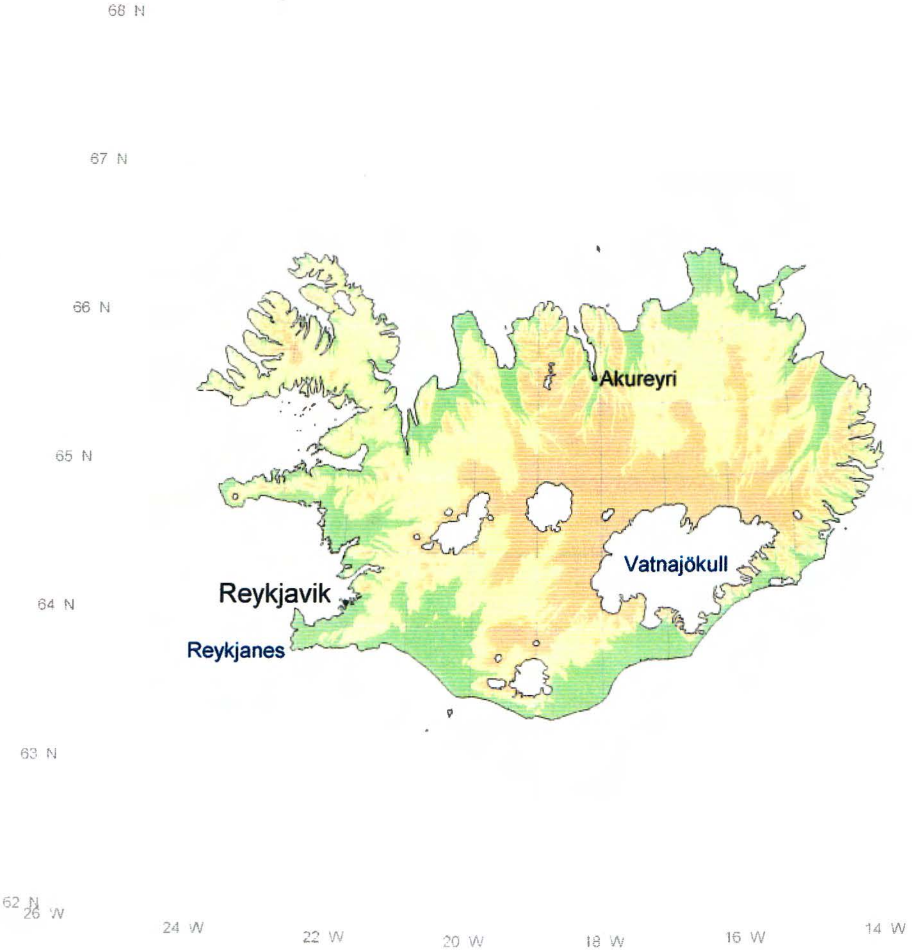

Figure 1.1 – Iceland. The geodetic grid marks the size of the study area. Height above sea level is indicated using the following colour code: green 0-200 m, light brown 200-600 m and brown >600 m. The white areas are glaciers.

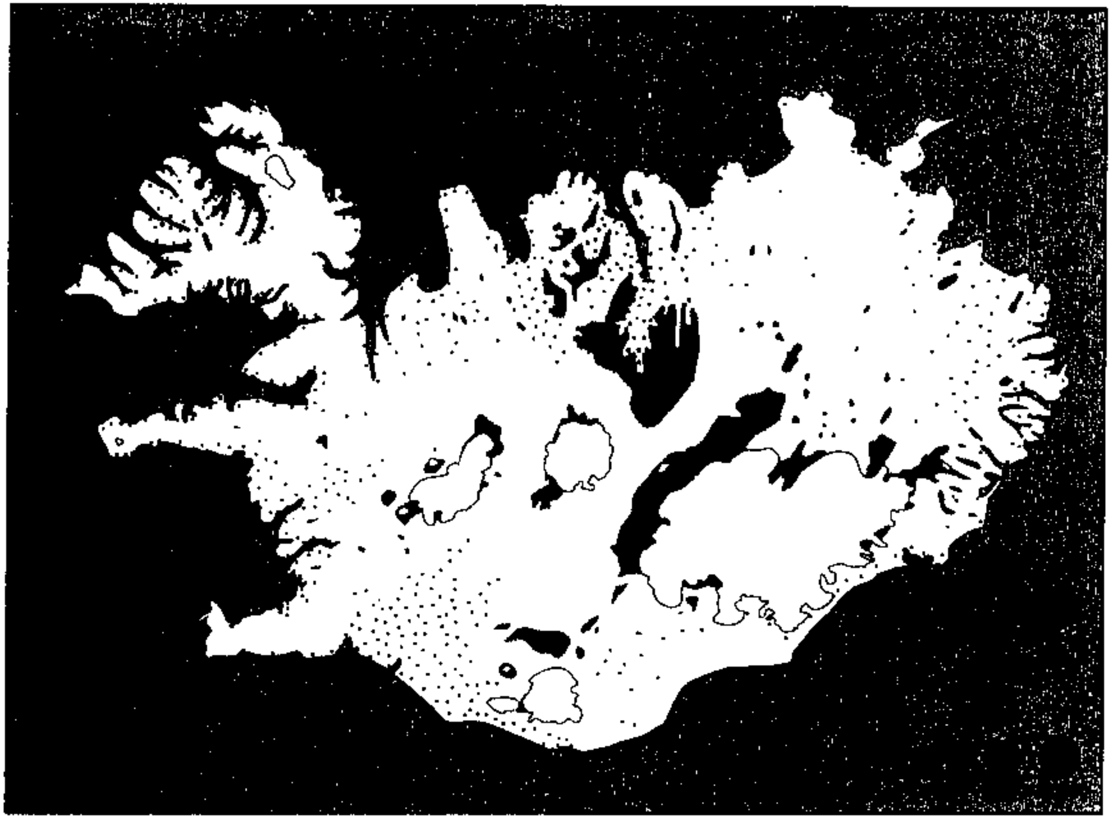

Figure 2.1 – Population desnisty 1890.

3. EPICENTRES

The greatest outstanding problem is the accuracy, particularly of pre-1960 macroseismic and instrumental epicentres.

In what follows, macroseismic epicentres are usually defined in terms of the location of the meizoseismal region of an earthquake. The use of this definition presents serious problems with earthquakes in Iceland not only because of its very low population density but also because the true epicentral region often lies off shore.

The first seismographic station in Iceland began operating in Reykjavik, for a few years first, 1910 to 1914, and then regularly from 1928 onwards with a two-component analogue seismometer (Mainka: V = 100, T = 6 seconds). The station was upgraded in 1951 with the addition of a Sprengnether seismometer. Before then, seismographic stations less than 20° degrees from Iceland were at Scoresby Sund (6.3°, from 1928), Edinburgh (12.4°, 1901), Paisley (12.0°, 1902), Eskdalemuir (12.8°, 1909), Disko (13.2°, 1907), Bergen (13.1°, 1905), Cork (14.1°, 1912), Bromwich (15.5°, 1909), Kew (17.0°, 1899), Kiruna (17.3°, 1951), Helgoland (18.0°, 1911), De Bilt (18.5°, 1904), Uppsala (18.7°, 1904), Copenhagen (18.9°, 1927) Uccle (19.2°, 1902) and Hamburg (19.3°, from 1900). Not all of these stations operated or reported continuously, and few were equipped with relatively sensitive instruments. The geographic distribution of these stations is indicated in Figure 3.1.

Instrumental epicentres reported by BAAS before 1918 are too crude, and, to a lesser degree, so are epicentral estimates reported by ISC before 1950, many of which are adopted without calculation.

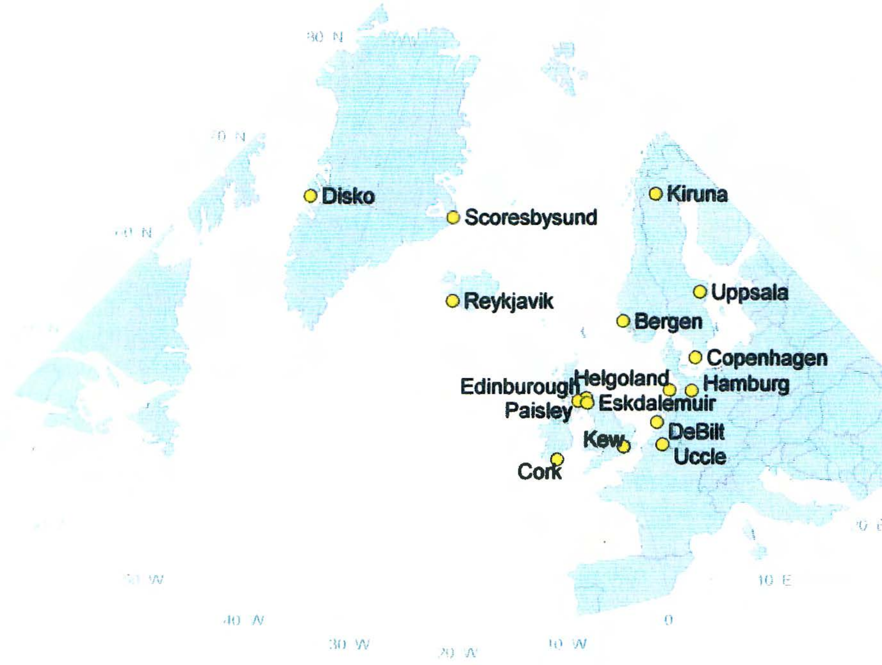

Figure 3.1 - Seismographic stations in 1951 located less than 20° from Iceland.

4. MAGNITUDES

Gutenberg and Richter [1954] have calculated surface-wave magnitudes of the few large earthquakes in our study area before 1950. Tryggvason [1973] supplemented this work by assigning local magnitudes to smaller events of the period 1928 to 1951, using a calibration formula derived for events in Iceland, details of which are not available.

The surface-wave magnitudes of a larger number of earthquakes, for the period before 1956, were estimated by Karnik [1968], who used the original version of the Prague formula. His M_S magnitude estimates are systematically smaller by 0.2 than Tryggvason's. This difference can be attributed to the fact that the latter used De Bilt as his standard station, which we know has a station correction of -0.2.

For later events, M_S values for some of the earthquakes have been estimated by different agencies, such as ISC and USGS. These estimates are based on a revised version of the Prague formula that restricts the use of surface-wave maximum amplitudes to periods in the range of 17 to 24 seconds.

Basic methodology

In this re-appraisal, M_S magnitudes of almost all earthquakes in the study area have been calculated uniformly, using only teleseismic data and standard procedures.

For the early period, 1896 to 1910, one method was to use maximum amplitudes from Milne pendulums, culled from the Shide Circulars (1899-1913), to calculate equivalent surface-wave magnitudes using the calibration formula:

$$M^* = \log_{10}(2A_t) + 1.25\log_{10}(\Delta) + 4.06 \qquad (4.1)$$

where $2A_t$ is the double trace amplitude in millimetres on standard Milne seismograms, and Δ is the epicentral distance in degrees [Ambraseys and Melville, 1982]. This method we find to be more stable for earthquakes of $M_S < 6.7$ in the study area than the method proposed by Abe [1981].

Another method was to use the amplitude and period of long waves written by other types of undamped or lightly damped pendulums, mainly of the Italian and Russian networks, and calculate an equivalent magnitude M# using the Prague formula [Vanek et al., 1962]. Here again, we find this method to be more suitable for earthquakes of all sizes than the method proposed by Abe [1994].

For the later period, and for the bulk of the data, we used the original Prague formula. Station surface-wave magnitudes M_S were calculated from the amplitude and period of long waves recorded by medium-period seismographs and reported in station bulletins. M_S estimates from close-in stations were corrected for distance, using the modified Prague formula in Ambraseys & Free [1997].

Broadband body-wave magnitudes m_b were estimated, using the Gutenberg distance-depth factor Q(Δ,h) for whichever phase PZ, PH, PPZ, PPH, or SH amplitude data was available in station bulletins. In all three methods, event magnitudes were obtained by averaging values calculated from individual station readings, the number of which varied with magnitude and year or occurrence.

In the Appendix A, we present the worksheets of our assessment of location and magnitude. For each event, we present focal estimates and magnitudes made by other writers. This is followed by a list of stations, geocentric distance and azimuth, the amplitudes (in microns) and periods (in seconds) of long waves recorded and the resulting station surface-wave magnitude. The mean value of the resulting event magnitude from the Prague and the modified-Prague formulae, their standard deviation and number of stations used are also shown. Magnitudes have been calculated, including outlier station estimates. The use of station corrections and the removal of outliers chiefly result in a reduction of the standard error, which for the original and modified Prague formulae result in a factor of 0.8 and 0.6, respectively.

Discussion on methodology

One of the purposes of this report is to provide homogeneous surface-wave magnitudes over a period of 100 years, which is a much longer period than that since the advent of the magnitude scale. These surface-wave magnitudes are needed for the study of continental deformation and for the assessment of seismic hazard. Another purpose, in this chapter, is to discuss in some detail the methods used to assess magnitude for the benefit of the engineer and, to some extent, the seismologist.

We uniformly reassessed surface-wave magnitudes for earthquakes in the region of Iceland from the beginning of this century to 1998 in the area between 62° and 68° N and 12° to 26°W, shown in Figure 5.1. The reason for this is that for many events in this region, event magnitudes are not known, or they are not homogeneous, having been calculated at different times using different scales.

Also, we used readings from Milne instruments for the early period from 1900 to 1918, to calculate equivalent surface-wave magnitudes. We have chosen to re-evaluate M_S of all earthquakes large enough ($M_s > 5.7$) to be of interest for the assessment of total strain measured geodetically for comparison with that accounted for by earthquakes and with estimates of fault slip rates measured at the surface. The data set for $M_S > 5.7$ is complete. Also, we have chosen to re-evaluate M_S of all earthquakes with reliable estimates of seismic moment M_o, regardless of magnitude, which could allow not only investigation of the scaling of surface-wave magnitude with seismic moment down to small magnitudes, but also extension of the period for which, via M_S, seismic moments can be assigned to events back to 1904. We also included for reassessment all events in our area whose magnitude was calculated by Gutenberg. In addition, we re-appraised the magnitude of smaller events ($M_S < 5.7$) associated with earthquakes whose magnitude has been over-estimated by other workers or agencies.

Surface-wave magnitude – According to Abe [1981], M_{GR}, the magnitude based on surface-waves for shallow events first used by Gutenberg and Richter [1936] is equivalent to a surface-wave magnitude [Gitenberg and Richter, 1954]. M_{GR} was devised to extend to teleseismic distances the local magnitude M_L, which had been defined in the previous year [Richter, 1935] and more thoroughly developed in a subsequent paper [Gutenberg, 1945]. The original M_{GR} scale was based on the maximum horizontal ground displacement, A_{max}, but it was specified that measurements were to be made at periods near 20 seconds, although it is evident from Gutenberg's work sheets - which are kept at the Millikan Memorial Library of the California Institute of Technology in Los Angeles - that quite often Gutenberg himself did not observe this rule. He used periods from 10 to 25 seconds, and quite often amplitude and period values that, on examination, are found to be different from those published in station bulletins. There are different interpretations of the structure of Gutenberg's magnitude, M_{GR}, of its changes over the time of its development and of the method this author used to choose maximum phase amplitudes, a subject which is outside the purpose of this report [Båth, 1969; Abe, 1981; Ambraseys and Melville, 1982; Lienkaemper, 1984].

Prague surface-wave magnitude – An improvement of the scale was made by Soloviev [1955] who proposed a surface-wave magnitude in which the maximum ground particle velocity $(A/T)_{max}$, a physical quantity accounting better for the seismic energy flux at a seismographic station than the ground displacement A_{max} at a 20 second period, was used as the variable. Soloviev's scale is not restricted to a given period, and $M_{S,i}$ can be calculated within a broad range of distances of 4 to 80 degrees. He defined the general formula for the station surface-wave magnitude as:

$$M_{S,i} = \log_{10}(A/T)_{max} + s(\Delta,h) + C(M) \qquad (4.2)$$

Here, A is a ground displacement in micrometres, T is the period in seconds associated with the maximum particle velocity $(A/T)_{max}$, $s(\Delta,h)$ is an empirical ground velocity-distance calibration function, expressing the change of particle velocity with epicentral distance Δ and focal depth h, and C(M) is a correction term allowing for the effects at the recording site, wave path, variations in depth and focal mechanism [Soloviev and Shebalin, 1957].

Karnik [1962] and Vanek et al. [1962], following Soloviev, proposed the following calibration relation:

$$s(\Delta) = 1.66 \log_{10}(\Delta) + 3.3 \quad (4.3)$$

which they derived originally from the weighted average of 14 attenuation functions existing at the time for epicentral distances between 20 and 160 degrees and for an wide range of surface-wave periods, to determine the value of $(A/T)_{max}$. These 14 attenuation functions and subsequent functions used to control equation (4.3) are given in Soloviev [1961, p.115], Karnik [1968, pp.56-60], cf. Lienkaemper [1984]. Later, the validity of equation (4.3) was confirmed further for smaller distances of a few degrees [Karnik and Christoskov, 1977; Karnik, 1977].

Calibration relation (4.3) was proposed by IASPEI in 1967, specifically in order to avoid the limitations imposed by the restriction to near 20 second period waves in Gutenberg's method. Equation (4.2), commonly referred to as the original "Prague formula", was then defined as:

$$M_{S,i} = \log_{10}(A/T)_{max} + 1.66 s(\Delta) + 3.3 + C_i \quad (4.4)$$

Here C_i is a station correction term, allowing for the effects at the recording site and wave path. Recommended period ranges corresponding to the maximum amplitudes of surface-waves at different epicentral distances were also given by IASPEI [1967], Karnik [1962] and Willmore [1979]. The Prague formula was devised to be used with shallow events ($h < 40$-50 km) and to have a depth adjustment for deeper events. We will not discuss here the derivation of depth correction.

However, with few exceptions, workers and agencies do not use the Prague formula according to its full original definition. Since the mid- to late 1970s, surface-wave magnitudes reported by both the National Earthquake Information Service (NEIS) and by the International Seismological Centre (ISC) have been computed and published using the Prague formula, but each agency selects data using different criteria inconsistent with the definition of the original Prague formula.

Up to 1975, NEIS published estimates of M_S from readings on horizontal components at individual stations, but as of May 1975, the assessment has been made only from the vertical component of the surface-wave within the restricted period range of 18 to 22 seconds and for distances between 20 and 160 degrees (see Lienkaemper [1984] for details). It is theoretically more correct to use the vertical component rather than the horizontal ones because the vertical component records only waves of the Rayleigh type, while the horizontal components record both Love and Rayleigh waves, with the resulting complication in attenuation characteristics. No depth or station corrections are applied by NEIS, and M_S magnitudes are not generally computed for events with focal depths greater than 50 km.

Before 1971, ISC neither reported long-period amplitudes and periods nor calculated M_S. Between 1971 and 1976, ISC reported amplitudes and periods for all components, and M_S was calculated by vectorially combining the maximum reported amplitudes of the two horizontal components at periods near 20 seconds for stations in the distance range of 20 to 160 degrees and using the attenuation relationship from the Prague formula. These determinations were given with the station readings only and were not included with the epicentres.

Between 1976 and 1978, magnitude determinations from the vertical components were included for very few events; the distance range was extended to between 5 and 160 degrees and the range of allowable periods to between 10s and 60s.

Since 1978, event magnitudes determined using these criteria have been given with epicentres, but for the whole period up to today only those stations at distances between 20 and 160 degrees are used in the averaging for an event magnitude and given as ISC M_S estimates, only for events at depths of 60 km or less. Thus M_S magnitudes reported by ISC are calculated with the exclusion of amplitude and period data from distances smaller than 20 degrees. We know little about the reasons for the adoption and changes, by ISC, of these procedures.

NEIS and ISC thus use different selection criteria in choosing stations for the calculation of $M_{S,i}$, and for a particular event, the number of stations used and their distribution in azimuth may be different. In addition, ISC usually uses more station readings than NEIS in determining event magnitudes, but neither of them reports the standard deviations of their estimates.

Errors in M_S magnitudes published by major agencies for more recent events are relatively few, but they do occur. A few gross errors were found in the routine calculation of $M_{S,i}$ by ISC. These are chiefly due to confusion between nanometres and micrometres in the reported amplitude, which results in individual station magnitudes being incorrect by three units. Such errors have a serious effect on event magnitude, particularly when the number of station magnitudes is small, and fortunately do not occur frequently. We understand that ISC has now modified its analysis procedure to detect suspiciously large ranges of station magnitudes for any given event.

Station corrections – Station correction C_i in Equation (4.4) for a particular station no. i is defined as the mean of the residual ($M_S - M_{S,i}$) over a period of time, i.e.:

$$C_i = \sum_{j=1}^{N} \frac{M_{S(j)} - M_{S,i(j)}}{N}$$

where N is the number of events observed by the station.

To the best of our knowledge, the first systematic estimation of station corrections from earthquakes in Europe was made by Karnik [1968] who employed the original Prague formula to assess corrections for 170 chiefly European stations. He used earthquakes in Europe and adjacent regions, of all magnitudes and depths, during a 48 year period between 1904 and 1951. The area is bounded by 30 to 75°N, and 20°W to 45°E, with a centre at 52°N-12°E, and it has a surface of 0.040·S, where S is the surface of the earth. In this European data set, almost all observing stations are inside the study area with Eurasian continental propagation paths.

Following Karnik's procedure, station corrections were calculated from shallow earthquakes of $M_S > 5.3$ in Iran, a smaller area than Karnik's of 0.006·S, for a 77 year period between 1903 and 1979. The area is bounded between 24 to 40°N, and 44 to 64°E, centred at 32°N-54°E, with all the observing stations outside the study area with almost exclusively Eurasian continental propagation paths [Ambraseys and Melville, 1982].

Christoskov et al. [1983] also calculated corrections for 32 stations, using 286 earthquakes in the Eurasian continent over a five year period between 1966 and 1970. However, their corrections cannot be compared with those from other studies as they have been calculated with respect to a zero station correction for Obninsk (OBN). The same applies for the station corrections determined by Bune et al. [1970] for the major seismographic stations in the former USSR.

Using Karnik's procedure, Ambraseys [1995] calculated station corrections from Central American shallow earthquakes of $M_S > 5.0$ for a 27 year period between 1904 and 1930. The study area is very small, only 0.003·S, bounded by 7 to 17°N and 80 to 93°W, centred at 12°N-84°W. All observing stations are outside the study area, and they have oceanic and mixed propagation paths.

More recently, Rezapour and Pearce [1998], using amplitude and periods reported by ISC from stations restricted to the distance range between 20 and 160 degrees, calculated corrections for stations world-wide from earthquakes throughout the world for the 16 year period of 1978 to 1993. All observing stations are inside the study area of 1.0·S, and propagation paths are mixed continental and oceanic. About 90 percent of the station corrections were calculated from vertical amplitudes only.

Distance correction of the original Prague formula – There is considerable discussion in the literature as to the best practice for the determination of surface-wave magnitude. Since its adoption by IASPEI in 1967, there has been much debate about the adequacy of the amplitude-distance function of $M_{S,i}$ in Equation (4.3) [Evernden, 1971; Marshall and Basham, 1973; Nuttli, 1973; Seggern, 1977; Christoskov et al., 1983; Panza et al., 1989; Herak and Herak, 1993; Vanek, 1995; Rezapour and Pearce, 1998]. It must be pointed out, however, that most of these authors examined the Prague formula at periods near 20 seconds in the distance range of 6 or 20 to 160 degrees, using M_S estimates made by NEIS or ISC, and not from station readings made according to the original definition of the scale.

Seggern [1977] found that the amplitude of Rayleigh waves near a period of 20 seconds attenuates slower, at a rate of $1.08 \cdot \log_{10}(\Delta)$, as compared with $1.66 \cdot \log(\Delta)$ in the Prague formula. Christoskov et al. [1983] obtained similar results, deriving a homogeneous M_S magnitude system for the region of the Eurasian continent, using 32 reference seismic stations. They derived calibration functions for surface-wave magnitudes from 4,862 LH observations of 286 shallow events for the five years between 1966 and 1970, in the distance range between 20 and 100 degrees, and with a successive optimisation of station adjustments with respect to Obninsk (OBN). These authors noted that a simple linear function could not accurately express the shape of the calibration function in the whole range of distances.

Evidence for a station magnitude distance adjustment of the Prague formula in our work came from a recent, unpublished study of a data set, which we used for the determination of station corrections for magnitudes associated with earthquakes that triggered strong-motion instruments in the European area. The data set consists of 4,800 station magnitudes $M_{S,j}$ and shows that the constraint of the selection of data to periods in the range 18 to 24 seconds resulted in a noticeable M_S distance dependence for $\Delta < 20$ degrees, causing an increase of the distance coefficient to 1.66 beyond that distance, a situation similar to that described by Evernden [1971]. However, the inclusion of data from events recorded over short distances, with surface-wave (Lg) periods down to 3 seconds reduced this need to adjust the distance term in the Prague formula, mainly by reducing the bias *implicit* in the choice of only near 20 second period wave amplitudes, which also reduces the number of data points available at close distances.

Herak and Herak [1993] used the data selection criteria employed by NEIS and a data set of 250 earthquakes reported by ISC/NEIS world-wide and vertical amplitudes recorded in the 18 to 22 22-second period range for an undefined distance range. They found that the rate of attenuation of the Rayleigh wave amplitude with distance is slower than defined in the Prague formula. They used a procedure in which the residuals between individual $M_{S,j}$ and M_S values extrapolated for each event to a distance of 100 degrees, termed the "representative" M_S, when plotted versus $\log(\Delta)$, shows that the Prague formula needs modification. They proposed that it should be replaced by:

$$M_{S,j} = \log_{10}(A/T)_{\max} + 1.094 \log_{10}(\Delta) + 4.429 \qquad (4.5)$$

A similar observation can be made with data exclusively from the European region when the data selection criteria and regression procedure adopted by

Herak and Herak [1993] (i.e., the use of vertical component and periods in the 18 to 22 second range) are used [Ambraseys and Free, 1997]. They find that:

$$M_{S,i} = \log_{10}(A/T)_{max} + 0.947\log_{10}(\Delta) + 4.77 \tag{4.6}$$

From 700 earthquakes in the larger European region of magnitude in the range of $3.5 < M_S < 7.4$, between 1977 and 1995, these authors re-examined the question of whether the original Prague formula needs an adjustment to the distance term. They examined the distance dependency of the residuals from station magnitudes and "representative" M_S values at distances of 60 and 100 degrees, and separately they examined the distance dependence of residuals from station magnitude and seismic moment. They found that the restriction of the data to the 18 to 22 second period range causes the original Prague formula to require a correction of its distance term for both global and regional data, and also that the selection of data over the much broader range implicit in the original version of the Prague formula reduces this requirement. They concluded that the use of the optimum "representative" M_S is at 60 degrees and that the correlation of M_S with seismic moment M_o confirms that distance dependence $dM = M_{i,3} - M_{i,1}$, where $M_{i,1}$ and $M_{i,3}$ are the station magnitudes calculated without and with distance correction, remains statistically significant but small:

$$dM = 0.518 - 0.282\log(\Delta) \tag{4.7}$$

when they adhere to the original definition of the Prague formula. The methods they used for calculating distance effects and separately using moment M_o were based on different principles and data, and it is reassuring that the results are so similar (see Ambraseys and Free [1997]).

Existing* M_S *magnitude estimates for the study area – In general, there are two kinds of parametric catalogues for surface-wave magnitudes:

(a) catalogues in which M_S was calculated homogeneously with a standard method from station magnitudes using amplitude and period data with or without station corrections, and

(b) less reliable catalogues in which event magnitudes, originally of the first kind or derived from other scales, have been "adjusted" empirically to fulfil some criteria of homogeneity and completeness of the catalogue, without resorting again to instrumental data.

When applied to data sets of the last two to three decades of relatively homogeneous information, these empirical techniques may recognise detection and reporting changes of a global network and occasionally magnitude shifts that can help "adjust" the data [Habermann, 1987; Perez and Scholtz, 1984; Pacheco and Sykes, 1992]. However, such techniques fail to identify regional magnitude biases, and they are not applicable to data sets, such as ours, spanning a period of 100 years of changing instrumentation, network density and distribution.

There are relatively few M_S estimates of the first kind for events before the mid-1960s in our area. The International Seismological Summary (ISS) calculated no magnitudes in the period of its operation up to 1963, and it is not until January 1978 that ISC started to report event magnitudes. For earthquakes after the mid-1960s, non-homogeneous M_S estimates have been made by different national centres that used a variety of different formulae to assess roughly equivalent surface-wave magnitudes M_S.

For the period before 1949, the main source of magnitudes of the larger earthquakes in our area are the calculations of Gutenberg and Richter [1954], while for the period 1950 to 1958, there are the estimates in Gutenberg's unpublished work-sheets.

Tryggvason [1973] assigned magnitudes to Icelandic events in the period of 1928 to 1951, but details of his method are not known.

For our area, surface-wave magnitudes were also estimated by Karnik [1968], who is perhaps the first to evaluate surface-wave magnitudes uniformly for European earthquakes between 1904 and 1955, using amplitudes and period data from horizontal components and the original Prague formula.

The most recent catalogue of the second kind is by Perez [1999]. Assuming that the rate at which $M_S > 6.0$ occurs in the entire world is constant and typical of all periods for shallow ($h < 70$ km) events, he adjusted M_S event magnitudes reported by ISS/ISC and NEIC to satisfy this postulate. It is hardly to be expected, however, that a natural system would be conservative in terms of M_S, which is not a physical parameter [Pacheco and Sykes, 1992]. Perez's data set includes magnitudes from different scales, a number of spurious events and magnitudes determined by LAO, the Large Aperture Seismic Array, which were included in international listings, such as that of ISC. However, LAO determinations are completely spurious, and only a few high-gain stations in the USA report some of their high assigned magnitudes. It seems that many of these reported events resulted from the automatic analysis that misinterpreted core phases, such as PKKP, from large events in an antipodal path, and their high apparent velocity resulted in their being ascribed to events in the far range of P-wave distance. Another source of contamination of this data set comes from the use of M estimates reported in the ISC Historical File in which magnitudes before 1977 have been adopted from other sources without calculation. ISC did not calculate surface-wave magnitudes before 1977.

Recapitulating, we have chosen for reappraisal events meeting at least one of the following criteria:

(1) reliable estimates of seismic moment M_0 (CMT or P/SH),

(2) magnitude equal to or greater than 5.7,

(3) magnitude calculated by Gutenberg.

(4) events in association with surface faulting,
(5) grossly overestimated M_S, (> 5.6) by other workers or agencies, and
(6) events recorded by strong-motion instruments or shocks causing exceptionally high damage of special interest to the engineer.

Data – For the period 1900 to 1971, amplitude and period data for the calculation of station magnitudes $M_{S,i}$ were taken only from station bulletins. After that period, the volume of the data required to calculate M_S, which is contributed by individual seismographic stations and ISC bulletins, varies. Some stations reported to ISC regularly, others discontinuously and some occasionally or too late for this information to be included in the ISC bulletins.

For practical purposes, our re-evaluation was divided into three broad, overlapping periods of observation, dictated chiefly by the type of instruments available:

(1) an early period from 1900 to 1918 in which the majority of instruments world-wide were undamped or lightly damped pendulums,
(2) a middle period from 1903 to 1971, predominantly of medium-period damped analogue recorders; and
(3) a modern period of digital seismographs after 1971.

One method to calculate an equivalent $M_{S,i}$ for events in the early period, 1900 to 1918, when no standard damped seismographs were available, is to use the maximum amplitude from the Milne pendulums, culled from the Shide Circulars (1899-1918), then use the formula (see Equation (4.1)):

$$M^* = \log_{10}(2A_t) + 1.25 \cdot \log_{10}(\Delta) + 4.06 \qquad (4.8)$$

where $2A_t$ is the peak-to-peak trace amplitude in millimetres and Δ the epicentral distance in degrees. This formula was originally derived from 23 earthquakes in Iran for which both M_S and M^* trace amplitudes were available [Ambraseys and Melville, 1982]. Additional data from another 95 shallow earthquakes in Eastern Europe, in the Mediterranean region, Western Asia and Africa showed that the constant term in Equation (4.8) may be magnitude dependent, with its value increasing from 4.0 to 4.4 as the magnitude increases from 6.0 to 7.0. For earthquakes of M_S less than about 6.7 in the European area and Central America, we find 4.04 to give more uniform residuals than the method proposed by Abe [1981]. Equation (4.8) was used in this study for only a very few earthquakes before 1904.

For the middle period, which starts in 1903 with the operation of analogue seismographs in Europe at Potsdam, Gottingen, Uppsala and Leipzig, we used the original Prague formula, and $M_{S,i}$ estimates were corrected for both station and distance using the modified Prague formula.

The same procedure was used for the calculation of M_S for the modern period after 1971, but about one-third of the amplitude and period readings were extracted from the Bulletins of the ISC and two-thirds from bulletins of seismographic stations that did not contribute readings to the ISC.

Amplitude/period data – In the calculation of M_S for the middle period, we used only ground amplitudes as reported in station bulletins. Where trace amplitudes were given, because of the uncertainties in the calibration constants of analogue seismographs, particularly before the late 1940s, these values were not converted into ground amplitudes and were not used.

In very few cases of saturation of the horizontal component, or when a station was operating only instruments with a single, vertical component, we used the amplitude from the vertical. This we did with the *a posteriori* observation that the difference between M_S derived from horizontal and vertical components is not large. From stations reporting amplitude and period data from more than one seismograph, we used only readings from standard instruments (Wiechert, Milne-Shaw, Galitzin). We did not use readings of maximum amplitude if no corresponding period was given, and we discarded readings that were obviously gross misprints and could not be rectified by referring to preliminary bulletins, or in a few cases to seismograms. These rules were used chiefly in the selection of data for the middle and early part of the recent periods.

With the exception of the period 1991-1993, we made all estimates of M_S from horizontal amplitudes recorded by medium-period seismographs. In the middle and modern periods, if vertical amplitudes were available, a separate estimate of M_S was made.

Station magnitudes were obtained from the horizontal components combined vectorially. When only one horizontal component was available, 0.1 was added to the station magnitude.

Some difficulties were encountered in extracting amplitudes from station bulletins. Before the mid-1920s, amplitudes in some station bulletins were often given with no indication of whether they were measured from peak-to-peak or from the base-line. In some cases in which this ambiguity could not be resolved, and we assumed that they were measured from the base line, the resulting station correction, for example for Potsdam (POT), became strongly negative and of the order of $\log_{10}(2) = 0.3$ magnitude units, which indicated that this bulletin reported double amplitudes.

In some instances, bulletins would change their reporting convention between double and single without notice, a change which in some cases could be confirmed only by comparing preliminary with final bulletins or rarely by referring to seismograms

Sometimes there were also errors in attributing phases to the correct event when two earthquakes occurred close together in time. We find also that the standard errors of the mean M_S for subcrustal and deeper events of the middle period are generally greater than for shallow events. For some earlier events, this is the result of the wrong phase identification with other long-period phases being incorrectly reported in bulletins as surface-waves.

During the middle and modern periods, there is sometimes confusion in the convention for summing amplitudes and periods for horizontal components. Some bulletins publish a single maximum amplitude and period without specifying whether this comes from a single component or from the geometric sum of the horizontal amplitude and the arithmetic mean of the corresponding periods.

Between 1945 and the 1970s, there was a drastic decrease in the reporting in bulletins of the amplitude and period data needed to assess M_S. Many bulletins stopped reporting maximum amplitudes of long-period phases and listed only periods. Other stations stopped reporting amplitudes and periods of maximum phases altogether, listing instead of this information for body waves and giving an unspecified station magnitude.

In many instances readings of surface-wave amplitudes and periods from some networks do not reach the main agencies, and only a fraction of such data that is available in station bulletins from the Chinese, and from networks of the former USSR, is usually reported by and used in the ISC bulletins. For instance, amplitude and period data from Uppsala (UPP) and Kiruna (KIR), stations that have a long history of full reporting of these values in their bulletins since 1905 and 1951, respectively, are not reported to the ISC. The absence of this data from the calculation of M_S introduces an azimuthal and distance bias, which is particularly important for earthquakes observed by few stations.

Epicentral distance – Station epicentral distances D used in magnitude calculations are either from macroseismic locations or from instrumental determinations adopted from reliable sources or, for early events, recomputed in this study. Macroseismic epicentres have been estimated only for events with epicentral areas on land, chiefly of magnitude less than 6.5. Instrumental locations have been recalculated using standard ISC procedures with ISS/ISC input data, or adopted from Engdahl et al. [1998], ISC or the former USSR network.

Focal depth – The Prague formula was devised to be used with shallow events ($h > 40$ km) and should have a depth adjustment for deeper events. However, focal depths from teleseismic determinations are notoriously unreliable, so that reliable depth correction can be assessed only from a small sample in which depth was calculated from P/SH solutions or from special studies. In this study we re-appraised M_S only for events with $h > 40$ km for which we used somewhat improved depth estimates from Engdahl et al. [1998].

Event magnitude $\mathbf{M_S}$ – Station magnitudes $M_{S,i}$ estimated for the same event by different stations often diverge. Some such divergences represent real irregularities in wave propagation, while systematic magnitude station errors may arise from other factors, and these can be corrected using station corrections. The detailed study of the various factors that influence station corrections is beyond the scope of this study. Event magnitudes are calculated from the arithmetic mean of station magnitudes. At this stage, we may examine the effect of methods of averaging $M_{S,i}$ to calculate M_S.

Some authors usually reject from the summation uncorrected station magnitudes $M_{S,i}$ falling outside a given range from the mean. Gutenberg and Karnik used *ad hoc* ranges of exclusion of a whole and half magnitude unit respectively, and Lienkaemper [1984] used probabilistic criteria to exclude $M_{S,i}$ values from averaging, without prior scrutiny of the quality of data.

We preferred first to discard, on specific grounds, suspect amplitude and period data and then to calculate $M_{S,i}$ with station corrections using the original Prague formula. We find that quite a few stations, particularly in the early and middle periods, required corrections by as much as ± 0.3 to ± 0.5 magnitude units, the application of which reduced considerably large differences from the mean with the result that no *ad hoc* exclusion criteria are needed

Another problem that possibly escapes attention because it is so familiar is the method of averaging the station magnitudes $M_{S,i}$ to calculate event magnitude M_S. In the current procedure, the magnitude of an earthquake M_S is calculated from the arithmetic mean of station magnitudes $M_{S,i}$, which involves the mean of the $\log_{10}(A/T)$ terms from different stations. However, the average seismic energy density at a station is proportional to (A/T) and not to $\log_{10}(A/T)$, and therefore when the $M_{S,i}$ values are averaged, the M_S value is underestimated. This would not be a problem if the underestimation was constant but it varies depending on the distribution of station magnitudes, $M_{S,i}$.

Consider the general station magnitude equation:

$$M_{S,i} = \log_{10}(A/T) + b \cdot \log_{10}(\Delta) + c \qquad (4.9)$$

where b and c are constants. This can be transformed to:

$$10^{M_{S,i}} = 10^c \Delta^b (A/T) \qquad (4.10)$$

Therefore, $10^{M_{S,i}}$ is proportional to the energy density at the station. Hence, the new event magnitude, $M_{S,n}$, could be more correctly defined as:

$$M_{S,n} = \log_{10}\left(\sum_{i=1}^{N} \frac{10^{M_{S,i}}}{N} \right) \qquad (4.11)$$

Note that if there is only one station magnitude, then $M_S = M_{S,n}$, therefore the original station magnitude definition is correct.

It can be shown, by means of an expansion, that:

$$M_S \le M_{S,n} \tag{4.12}$$

as long as the differences between $10^{M_{S,i}}$ and $10^{M_{S,n}}$ are not too great. The difference between $M_{S,n}$ and M_S can be estimated by R:

$$R = \frac{1}{2\ln(10)N}\sum_{i=1}^{N}\left(\frac{10^{M_{S,i}} - 10^{M_{S,n}}}{10^{M_{S,n}}}\right)^2 \tag{4.13}$$

which depends on the variance of $10^{M_{S,i}}$. Although there is no exact relationship between R and the variance of $M_{S,i}$, they are roughly proportional. Thus, the underestimation in magnitude by using M_S rather than $M_{S,n}$ is greatest when the station magnitudes are widely distributed about the event magnitude. R is a good estimator of the error when the underestimation is less than about 0.25 but a poor estimator for larger errors. This is due to the higher order terms in the expansion becoming more important.

Seismic Moment – Seismic moment M_o is a better measure of the size of an earthquake than M_S, but it is available only for the larger events of the last two decades. M_o scales well with M_S over a wide range of magnitudes, but seismologists and engineers alike often misunderstand its use. Kanamori [1977] defined the seismic energy magnitude M_w as a linear transformation of the logarithm of the seismic moment M_0 given by:

$$M_S \sim M_W = \tfrac{2}{3}\log_{10}(M_o) - 10.73 \tag{4.14}$$

in which M_o is in dyn·cm units (10^{-7} Nm). Kanamori derived Equation (4.14) from the observation that in most cases consisted of large, $M_S \le 7.5$, shallow earthquakes with a stress-drop of about 30 bars, which he combined with the energy (E) and magnitude (M_S) relation for earthquakes in California, i.e.:

$$\log_{10}(E) = 11.8 + 1.5M_S$$

which in reverse form, is similar to Equation (4.14).

Moment magnitude **M** for shallow earthquakes, in California in the range $5.0 \leq M_S \leq 7.5$, was then defined by Hanks and Kanamori [1979] as being equal to M_w from Equation (4.14).

There is some confusion in literature about the definition and use of moment magnitude **M**. The equality $\mathbf{M} = M_w = M_S$, as defined above, holds only for events that rupture the entire thickness of the seismogenic zone, and its validity, therefore is regionally dependant [Ekstrom and Dziewonski, 1988]. **M** is nothing more than a definition, or a transformation of M_o through Equation (4.14), and for the region of our interest, we have that $\mathbf{M} \leq M_S$ for about $M_S < 6.0$. For the sake of clarity, we avoided the use of **M** or M_w in this work.

Relations between surface-wave magnitude M_S and seismic moment M_o, and vice versa, provide suitable functions for the correlation between one source size indicator and the other. Current relationships for assessing M_o from the surface-wave magnitude M_S of shallow earthquakes have been derived from global or large sub-global data sets for active regions [Ekstrom and Dziewonski, 1988; Rezapour and Pearce, 1998; Perez, 1999] and for stable continental regions [Johnston 1996a, b].

Ekstrom and Dziewonski [1988] derived global relationships between M_S and $\log_{10}(M_o)$, in which the independent variable is $\log_{10}(M_o)$. They used 2,341 reported M_S values from the Preliminary Determination of Epicentres (PDE) and corresponding scalar moments from the Harvard CMT catalogue. Only events up to 1987, for which both the NEIC and the CMT depths are less than 50 km, were considered in $\log_{10}(M_o)$, ranging from 23.5 to 28.6.

A relationship was then determined in the form:

$$M_S = k - \frac{(a+b)}{6} + \log_{10}(M_o) \qquad \log_{10}(M_o) < a \qquad (4.15a)$$

$$M_S = k - \frac{(a+b)}{6} + \log_{10}(M_o) - \frac{(\log_{10}(M_o) - a)^2}{6(b-a)} \qquad a \leq \log_{10}(M_o) \leq b \qquad (4.15b)$$

$$M_S = k + \tfrac{2}{3}\log_{10}(M_o) \qquad b < \log_{10}(M_o) \qquad (4.15c)$$

Note that Equation (4.15a) was derived on the assumption that the slope is one for $\log_{10}(M_o) < a$, and Equation (4.15c) on the assumption that the slope is 2/3 for $\log_{10}(M_o) > b$. The constants in Equations (4.15) were determined by minimising

$$\sum_{i=1}^{N} \left(M_S(\log(M_o), i, a, b, k) - M_{Si}\right)^2$$

with respect to a, b and k. Rather than summing over N earthquakes, a reduced data set was used in which M_S was averaged for earthquakes in narrow ranges of $\log_{10}(M_o)$ of 0.1 units, so that only about 40 summary data points were considered.

A good fit to the reduced data for earthquakes with moment as the independent variable in the range $2 \cdot 10^{24}$ to 10^{28} dyn·cm was obtained with a = 24.5, b = 26.4 and k = -10.76, which reduce Equations (4.15) to:

$$M_S = -19.24 + \log_{10}(M_o) \qquad \log_{10}(M_o) < 24.5 \qquad (4.16a)$$

$$M_S = -19.24 + \log_{10}(M_o) - 0.088(\log_{10}(M_o) - 24.5)^2 \qquad 24.5 \le \log_{10}(M_o) \le 26.4 \qquad (4.16b)$$

$$M_S = -10.76 + \tfrac{2}{3}\log_{10}(M_o) \qquad 26.4 < \log_{10}(M_o) \qquad (4.16c)$$

These authors then rewrite Equation (4.16) in the form:

$$\log_{10}(M_o) = 19.24 + M_S \qquad M_S < 5.3 \qquad (4.17a)$$

$$\log_{10}(M_o) = 30.20 - (92.45 - 11.40 M_S)^{0.5} \qquad 5.3 \le M_S \le 6.8 \qquad (4.17b)$$

$$\log_{10}(M_o) = 16.14 + 1.5 M_S \qquad 6.8 < M_S \qquad (4.17c)$$

However, since Equations (4.17) are Equations (4.16) rewritten, they are **not** the correct relationships for estimating $\log_{10}(M_o)$ from M_S.

5. PARAMETRIC CATALOGUE OF EARTHQUAKES

Table 5.1 lists all the retrieved events recorded in our study area from 1896 to 1996. The catalogue is divided into the three parts discussed in the preceding section and outlined in the worksheets (see Appendix A), i.e., the BAAS period from 1896 to 1918, the ISS period from 1918 to 1966 and the ISC period from 1964 to 1995. This division indicates the main sources of the applied teleseismic data.

An annexation to the parametric catalogue is given in Table 5.2. In the table, the origin time, hypocentral location, recalculated surface-wave magnitude and CMT seismic moment are listed for selected events. The unit of the seismic moment, M_o, is dyn·cm and the values in the table are $\log_{10}(M_o)$.

Table 5.1 – Parametric earthquake catalogue for Iceland. Period: 1896 to 1996. Area: 62°-68° N and 12°-26° W. A key to the table is given on page 36.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
Part I – The BAAS period										
1896 Aug 26	2320	63.97-20.20m	n	6.62	3	9				6.5A
1896 Aug 27	1047	64.13-20.25m	n	6.12	3	5				6.2A
1896 Sep 05	2357	63.98-20.70m	n	6.35	2	6				6.5A
1896 Sep 06		63.98-21.20m	n					00		
1896 Sep 10		63.95-20.85m	n					00		
1899 Jan 31	1112	66.30-19.90m	n	5.77	-	1				
1899 Feb 23	1336	63.50-23.50m	n	5.7*	2	4				
1899 Feb 26	1336	64.50-23.00m	n	5.7*	2	2				
1899 Feb 27	1117	63.95-22.80m	n	6.03	-	1				
1899 Feb 27	1521	63.80-22.80m	n	5.95	-	1				
1904 Jun 15	24--	64.00-20.00m	n					00		4.6K
1904 Aug 02	1012	66.30-18.70	n	5.59	1	4				
1905 Jan 28	0618	63.95-22.00m	n							5.6K
1905 Nov 15	0650	66.20-18.00m	n	5.49	4	3				5.1K
1905 Nov 19	2335	64.00-20.00	n	5.36	-	1				
1906 Jan 13	19--	63.90-20.00m	n					00		4.6K
1906 Mar 19	0757	68.70-17.00	n	6.62	1	5	*6.7			5.9K
1906 Nov 9	0220	66.20-18.00m	n	4.68	2	4				4.6K
1908 Oct 14	1800	63.90-23.00m	n							4.6K
1908 Dec 26	0704	66.20-18.00m	n	5.03	0	2				4.6K
1909 Feb 23	0430	64.00-20.10						00		
1910 Jan 22	0848	66.50-17.50m	n	7.19	3	14	*7.1			7.0A
1910 Jan 22	1045	63.85-23.00m	n							5.1K
1912 May 06	1859	63.98-19.83m	n	7.05	3	18	*6.9			7.0A
1913 May 19	1545	66.30-18.80	n	5.63	2	5	*6.3			5.5K
1913 Jul 26	2051	67.00-18.00	n	5.69	3	9	*6.0	42		5.6K
1914 Jun 19	0006	63.50-24.00r	n	5.14	3	7	*5.8	21		5.2K
1917 Jul 9	0022	62.70-21.40	n	5.79	1	3		18		5.3K
Part II – The ISS period										
1919 Feb 15	0217	68.20-13.00	n	5.28	3	2		23		5.1K
1920 May 14	1757	64.00-22.00m	n	5.16	4	4		20		5.2K
1920 Jun 25	1822	64.50-23.40	n	4.87	-	1		10		4.8K
1921 Aug 23	2017	67.00-18.00	n	6.39	3	13	*6.3	56		6.3K
1922 Nov 13	0356	66.50-19.50r	n					15		4.8K
1923 Oct 20	0024	65.00-15.00r	n	4.99	2	2		17		4.7K
1923 Oct 23	1637	65.00-16.50r	n					7		
1924 Sep 04	1601	63.90-22.05m	n	5.26	3	9	*5.8	35		5.1K
1924 Dec 12	0220	63.80-22.80m	n	5.24	1	2		17		4.7K
1926 Sep 22		63.80-22.80m	n					00		5.1K
1926 Oct 25	1104	63.80-22.80m	n					1		4.7K
1927 Apr 29	1119	66.30-19.50m	n	5.07	-	1		24		4.8K
1927 Jul 31	2059	66.50-19.00r	n	4.80	1	4		19		4.6K

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1928 Aug 1	1653	62.70-25.00r	n					6		4.5K
1928 Aug 1	1903	62.70-25.00r	n	4.86	-	1		6		4.2K
1928 Aug 1	1946	62.70-25.00r	n	4.67	2	2		17		4.6K
1928 Aug 1	2028	62.70-25.00r	n	4.69	3	2		15		4.7K
1928 Aug 1	2035	62.70-25.00r	n					1		4.2K
1928 Aug 1	2046	62.70-25.00r	n	4.67	2	2		10		4.7K
1928 Nov 6	0030	63.80-22.80m	n					00		5.1K
1928 Nov 22	0720	63.80-22.80m	n					00		4.6K
1928 Nov 22	1217	63.80-22.80m	n					00		4.6K
1928 Dec 2	2252	64.00-21.30m	n					2		4.6K
1928 Dec 6	1522	64.00-21.30m	n					1		4.6K
1929 Jan 6	0002	63.70-23.00m	n	5.41	0	2		26		5.4K
1929 May 24	0650	63.80-22.80m	n					00		4.6K
1929 Jul 23	1843	63.90-21.70m	n	6.31	3	21		97		6.3K
1929 Jul 23	2004	63.90-21.70m	n	5.35	2	3		18		5.1K
1930 Apr 8	1135	63.80-22.80m	n					1		4.2K
1930 Aug 25	1535	63.90-22.20m	n	4.73	-	1		2		4.5K
1931 Jan 31	0704	64.00-21.50m	n					1		3.7K
1931 Aug 23	1005	64.00-21.50m	n					2		3.7K
1931 Aug 23	1553	64.00-21.50m	n					2		5.1K
1932 Mar 18	0722	63.80-22.80m	n					1		3.7K
1932 Mar 18	0850	63.80-22.80m	n					00		3.7K
1932 Mar 18	0929	63.80-22.80m	n					1		3.7K
1932 Mar 18	2045	63.80-22.80m	n					00		3.7K
1932 Mar 18	2157	63.80-22.80m	n					1		3.7K
1932 Apr 17	1334	63.80-22.80m	n					1		4.2K
1932 Nov 2	0842	63.80-22.90m	n					1		4.6K
1932 Nov 2	1233	63.80-22.90m	n					1		5.1K
1932 Nov 2	1431	63.80-22.90m	n					1		4.6K
1933 Jun 10	1207	63.90-22.20m	n	5.69	2	13		64		5.6K
1933 Jun 10	1415	63.90-22.20m	n					0		4.2K
1933 Jun 10	1513	63.90-22.20m	n					3		4.2K
1933 Jun 10	1630	63.90-22.20m	n	4.81	-	1		15		4.6K
1933 Jun 10	2038	63.90-22.20m	n					3		4.2K
1933 Oct 5	0550	68.50-19.50A	n	5.05	0	2		12	i	4.9K
1933 Oct 5	0622	68.50-19.50A	n	5.13	1	3		15	i	5.0K
1934 Jun 02	1342	65.95-18.50m	n	6.17	2	26	*6.2	118		6.1K
1934 Jun 2	1455	65.95-18.50m	n					1		4.6K
1934 Jun 2	1836	65.95-18.50m	n					1		4.6K
1934 Jun 3	2034	65.95-18.50m	n	4.89	4	2		12		4.4K
1934 Jun 4	1455	65.95-18.50m	n					00		4.6K
1934 Jun 4	2110	65.95-18.50m	n					00		4.6K
1934 Jun 5	1200	65.95-18.50m	n					00		5.1K
1934 Jun 9	1410	65.95-18.50m	n					00		4.6K
1934 Jun 16	0840	65.95-18.50m	n					00		4.6K
1934 Jun 20	1740	65.95-18.50m	n					00		5.1K

Table 2.1 – Cont.

Date	OT(GMT)	Epicentre	h	M_S	S	n	m_r	N	A	M
1934 Jul 5	0745	65.95-18.50m	n					00		5.6K
1935 Oct 9	2208	63.95-21.50m	n	5.73	3	20		76		5.8K
1935 Oct 14	1030	64.00-21.50m	n					16		4.6K
1936 Jul 14	1837	64.40-20.70m	n					1		4.5K
1936 Sep 21	1810	63.80-22.80m	n					15		4.6K
1936 Oct 22	2349	66.80-17.40m	n	5.32	3	19		45		5.3K
1936 Oct 23	0000	66.80-17.40m	n	5.40	3	15		36		5.4K
1936 Oct 23	0250	66.80-17.40m	n					4		4.5K
1938 Feb 10	0703	64.60-23.00m	n	5.20	1	3		70		5.2K
1938 Feb 10	0829	64.60-23.00m	n					2		4.8K
1938 Jul 8	2251	66.50-17.00m	n					1		4.2K
1938 Jul 9	0921	66.50-17.00m	n					1		4.2K
1940 Jan 12	0940	66.00-17.50m	n					00		4.6K
1940 Jun 4	0150	63.80-22.80m	n					1		5.1K
1942 Apr 25	2002	66.30-19.50m	n					00		4.5K
1942 Jun 17	2214	64.00-20.70m	n					00		4.2K
1942 Nov 19	1755	63.50-23.00m	n					00		4.8K
1944 Feb 4	1833	66.10-17.50m	n					2		4.6K
1944 Feb 6	1706	66.10-17.50m	n					1		4.6K
1944 Feb 10	0320	66.10-17.50m	n					00		4.1K
1944 Feb 19	1135	63.40-23.80r	n	5.41	3	6		29		5.4K
1944 Feb 20	1932	63.40-23.80r	n	5.07	1	3		16		5.5K
1944 Feb 21	1526	63.40-23.80r	n	5.18	0	4		15		5.2K
1944 Feb 21	1734	63.40-23.80r	n	4.97	0	2		14		5.0K
1944 Aug 22	2140	66.10-17.50m	n					1		4.6K
1947 Mar 29	0750	64.00-19.70m	n	4.76	0	2		12		5.0K
1947 May 19	0657	64.00-21.20m	n					1		3.7K
1947 May 19	1143	64.00-21.20m	n					2		4.2K
1947 May 25	0401	63.90-22.10m	n					2		4.2K
1947 Jun 28	1724	66.30-19.00m	n					4		4.2K
1947 Jun 28	2222	66.30-19.00m	n					23		4.5K
1947 Aug 12	1559	64.00-19.70m	n					13		4.1K
1948 Jun 24	0206	63.90-22.10m	n					15		4.9K
1948 Jun 24	0212	63.90-22.10m	n	4.9		1				5.1K
1948 Jul 3	1545	64.00-20.50m	n	4.52	1	2		14		4.7K
1948 Aug 30	0139	66.50-18.00m	n	4.75	1	3		23		4.6K
1950 Jul 19	0536	63.80-20.80m	n	4.9		1		15		4.9K
1952 Mar 12	1213	63.90-22.10m	n	4.71	2	3		35		4.7K
1952 May 16	1432	63.90-22.00m	n	4.84	2	2		13		4.8K
1955 Jan 15	1646	63.90-22.25m	n					1		4.6K
1955 Feb 27	0737	66.20-16.30m	n							4.6K
1955 Feb 27	0747	66.12-16.25	n				4.4		s	4.6K
1955 Feb 27	0828	66.20-16.30m	n							4.6K
1955 Feb 28	0400	66.20-16.30m	n							4.6K
1955 Mar 13	0213	64.20-20.70m	n							4.6K
1955 Apr 1	1726	64.10-21.20m	n							4.6K

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1955 Apr 1	1841	64.10-21.20m	n	4.91	1	3	*5.1	40		5.2K
1955 May 19	0311	66.50-17.50m	n	4.36		1	*5.2			5.0K
1956 Jun 1	1046	63.96-21.88	n	4.05		1			s	4.7s
1956 Jun 10	1405	64.40-17.70	n	4.24	1	2				4.7r
1956 Oct 29	1348	66.46-19.02	n						s	4.5s
1956 Oct 29	1621	66.46-17.73	n	4.63		1			s	4.6s
1956 Oct 29	1632	66.59-17.09	n						s	4.3s
1956 Oct 30	0011	66.48-17.73	n	4.82	2	4			s	4.9s
1957 Dec 9	0802	64.72-18.05	n						s	4.5s
1958 Feb 16	2302	67.61-18.84	n	4.60	1	3			s	4.5s
1958 May 19	1725	63.79-19.22	n						s	4.0s
1958 Sep 27	1041	66.07-18.08	n	3.94		1			s	4.6s
1958 Dec 6	0943	66.42-18.75	n						s	3.9s
1958 Dec 6	1112	66.42-18.27	n						s	4.7s
1958 Dec 6	1533	66.40-18.12	n						s	4.6s
1959 Feb 2	1554	64.56-17.24	n						s	4.0s
1959 Jun 28	0423	63.97-19.32	n	4.38	2	5			s	4.7s
1959 Dec 8	0808	66.95-18.78	n	4.54		1			s	4.8s
1960 Feb 21	0423	64.59-17.09	n						s	4.3s
1961 May 14	1508	67.70-18.40	n	4.31	1	5			u	
1961 May 14	1538	67.65-18.56	n	4.66	1	6			u	4.8u
1961 Oct 26	1155	65.10-16.70	n						b	
1962 Jun 12	0126	64.80-16.80	n	3.7		1			b	4.2s
1962 Jun 12	0946	64.90-17.10	n	4.06	0	3			b	4.4s
1962 Dec 15	0347	67.40-13.90	n						b	
1963 Mar 28	0016	66.37-19.69	n	6.85	1	14	*6.7	63	i	6.8u
1963 Mar 28	0026	66.30-20.20	n	4.0		1	4.6		u	5.0u
1963 Mar 28	0059	66.40-19.60	n				4.5		u	4.7u
1963 Mar 28	0128	66.60-20.00	n						u	4.6u
1963 Apr 27	0342	66.70-19.20	n	4.34	1	4	4.6		u	4.6u
1963 Jun 28	1515	67.20-18.70	n				4.3		u	
1963 Jun 28	1601	67.50-18.70	n	3.97	1	2	4.4		u	4.2u
1963 Sep 3	0913	62.80-25.20	n	4.28	1	6	4.9		u	4.3u
1963 Oct 15	0959	67.20-18.40	n	5.71	2	12	5.2		u	5.6u
Part III - The ISC period										
1964 Feb 26	2259	64.70-17.30	n	3.8		1	4.5	8	i	
1964 Jul 11	1744	66.24-19.86	17	4.54	1	15	4.9	95	e	
1964 Aug 20	0356	63.89-20.48	21	4.87	1	15	4.0	84	e	
1965 May 29	2256	63.15-24.60	n	4.16	0	2	4.4	21	i	
1965 Jul 11	0952	62.36-25.65	15				4.6	31	e	
1966 Mar 26	1229	63.09-24.38	32	4.32	0	2	4.6	28	e	
1966 Apr 08	2317	67.80-19.20	n	4.21	0	2	4.3	12	i	
1966 Dec 22	1539	64.63-17.20	n				4.8	7	i	
1967 Mar 11	1223	63.70-19.00	n				4.4	16	i	
1967 Apr 1	1242	63.62-19.05	17	4.5		1	4.8	56	e	

Table 2.1 – Cont.

Date	OT(GMT)	Epicentre	h	M_S	S	n	m_b	N	A	M
1967 May 16	1611	63.59-18.90	4	4.09	1	6	4.3	24	i	
1967 Jun 7	0258	63.56-19.25	26	4.00	1	2	4.5	36	e	
1967 Jul 26	2159	66.39-17.20	n				4.2	14	i	
1967 Jul 27	0517	63.97-20.87	1	4.61	1	7	5.0	96	e	
1967 Jul 28	1535	64.00-20.94	1	4.38	0	6	4.7	80	e	
1967 Jul 29	0221	63.90-20.80	n	4.23	1	6	4.7	46	i	
1967 Sep 30	0234	63.80-22.70	13	4.56	1	2	4.4	30	i	
1967 Sep 30	0419	63.80-22.70	n	4.56	1	2	4.4	23	r	
1967 Sep 30	0420	63.90-22.28	n				4.5	15	r	
1967 Sep 30	0430	63.97-22.40	n	4.42	0	2	4.3	23	i	
1967 Oct 04	2147	63.66-19.15	10	4.53	0	3	4.5	28	e	
1967 Nov 06	0411	67.90-18.70	n				4.2	15	i	
1967 Nov 06	0549	67.90-18.90	n	4.03	4	2	4.4	24	i	
1968 Jul 30	0224	66.42-17.50	1	4.25	0	2	4.3	27	i	
1968 Nov 08	1611	64.39-18.10	n	4.71	3	4	4.4	37	i	
1968 Nov 09	1920	64.03-21.12	5				4.4	46	e	
1968 Dec 5	0944	63.90-21.81	5	5.97	2	30	5.5	239	e	
1969 Apr 1	0410	66.44-17.67	9	4.25	1	6	4.5	48	e	
1969 Apr 3	1652	66.39-17.80	n				4.4	18	i	
1969 May 5	2147	66.90-18.28	1	5.09	2	11	5.2	144	e	
1969 May 5	2339	66.80-18.60	n				4.3	11	i	
1969 May 6	2356	66.55-18.00	n	3.8		1	4.5	11	i	
1969 Aug 26	2240	66.54-17.70	3				4.3	23	i	
1969 Aug 26	2247	66.44-17.51	8	4.33	1	7	4.9	57	e	
1969 Aug 26	2349	66.51-17.80	n	4.11		1	4.4	19	i	
1969 Aug 27	1212	66.50-17.70	n				4.4	23	i	
1970 Feb 08	1117	64.77-17.50	n				4.0	19	i	
1970 Jul 19	0501	62.81-24.60	n				4.0	9	i	
1970 Nov 06	0715	63.84-23.20	8	4.53	2	5	4.2	29	i	
1970 Nov 06	1125	63.70-23.30	n	4.49	2	4	4.3	28	i	
1971 May 13	2008	63.90-23.20	n	4.16		1	4.4	12	i	
1971 Aug 29	1056	67.69-18.92	22	4.79	1	11	5.0	100	e	
1971 Nov 10	1528	63.90-22.00	n				4.1	15	r	
1971 Nov 19	0120	63.80-22.40	6				4.3	15	i	
1971 Nov 19	0257	63.75-22.90	5	4.62	2	7	4.8	67	e	
1971 Nov 19	0557	63.84-22.65	12	4.43	0	3	4.6	29	e	
1971 Nov 28	1301	62.90-25.40	n				4.7	22	i	
1971 Nov 28	1304	62.90-25.00	n				4.8	15	i	
1972 Jan 01	1301	63.90-22.17	3	4.66		1	4.3	35	r	
1972 Jan 01	1441	63.90-22.30	n				4.3	21	r	
1973 Apr 01	0851	67.69-19.03	10	4.54		1	4.5	35	e	
1973 Apr 23	0257	64.57-17.70	5				4.2	28	i	
1973 Sep 15	0145	63.82-22.31	1	5.31	2	34	5.3	200	e	
1973 Sep 15	0222	63.73-22.41	8	4.8		7	4.9	90	e	
1973 Sep 16	2126	63.87-22.35	6	5.23	2	38	5.2	192	e	
1973 Sep 16	2233	63.90-22.10	n	4.17	1	4	4.7	42	i	

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1973 Sep 17	0114	63.95-22.30	n				3.8	11	r	
1973 Oct 28	1001	66.93-19.39	n	3.8		1	4.5	27	i	
1973 Oct 28	1042	67.04-19.40	n				4.1	30	i	
1973 Oct 28	1048	67.13-19.20	n				4.3	41	i	
1973 Oct 28	1053	67.14-19.40	n				4.3	18	i	
1973 Oct 28	1112	67.12-19.17	6	4.19	2	9	4.7	62	e	
1973 Oct 28	1115	67.07-19.40	n				4.3	23	i	
1973 Oct 28	1125	67.03-19.20	n				4.2	20	i	
1973 Oct 28	1131	67.11-19.06	3	4.61	1	20	5.2	107	e	
1973 Oct 28	1147	67.13-19.06	n	4.0		1	4.6	36	i	
1973 Oct 28	1201	67.37-19.00	n				4.2	28	i	
1973 Oct 28	1425	67.18-19.25	n	4.27	1	12	4.5	48	i	
1974 Jan 15	1947	64.51-17.79	8	4.4		1	4.6	70	e	
1974 Mar 30	1841	63.83-23.20	n	4.55		1	4.4	33	i	
1974 Mar 30	1910	63.64-23.60	n	4.39		1	4.3	34	i	
1974 Mar 30	2016	63.48-23.50	n	4.36	1	2	4.4	32	i	
1974 May 11	0917	64.87-20.89	15	4.0			4.6	49	e	
1974 May 17	1427	64.66-21.28	4	4.54	2	9	5.0	144	e	
1974 May 18	2339	64.64-21.28	10	4.26	1	4	4.7	86	e	
1974 Jun 12	1608	64.76-21.00	5	4.33	1	3	4.9	68	e	
1974 Jun 12	1755	64.79-21.05	15	5.43	3	15	5.5	246	e	
1974 Jun 25	2223	64.66-17.60	9	4.85	4	18	5.1	212	e	
1974 Oct 11	0912	67.45-20.24	11	4.40	1	4	4.6	81	e	
1974 Dec 08	0026	63.61-23.20	9				4.2	27	i	
1974 Dec 08	0100	63.70-23.10	n				4.3	12	i	
1974 Dec 08	0126	63.65-22.90	28				4.2	15	i	
1974 Dec 29	0350	64.54-17.61	12	5.96	2	12	5.1	181	e	
1975 Mar 11	2342	66.20-18.57	13	4.16	1	9	4.5	59	e	
1975 Aug 13	1006	66.59-17.98	n	4.15	0	3	4.5	36	i	
1975 Sep 27	2245	62.03-26.70	n				4.7	27	i	
1975 Oct 03	1834	64.50-17.42	6	5.0		5	5.1	185	e	
1975 Dec 16	0357	66.50-18.08	10	4.0		1	4.6	36	e	
1975 Dec 23	1540	63.87-22.50	5	4.74		1	4.5	33	r	
1975 Dec 23	1606	63.91-22.09	n	4.60		1	4.5	34	i	
1975 Dec 24	0933	66.03-16.90	7	4.39		1	4.7	73	e	
1975 Dec 24	1741	66.02-17.12	34	4.5		1	4.8	29	i	
1975 Dec 25	0544	66.07-17.07	10	3.8		1	4.5	18	i	
1975 Dec 25	2204	66.26-16.41	5	4.89	4	15	5.0	169	e	
1975 Dec 26	0050	65.99-16.92	1	4.5		1	4.8	65	e	
1975 Dec 26	1656	66.13-16.86	10	4.3		1	4.7	26	i	
1975 Dec 26	2031	66.12-17.30	n				4.4	22	i	
1975 Dec 29	1045	66.05-16.91	2	5.11	2	6	4.7	75	e	
1975 Dec 30	1505	66.01-16.90	10	3.8		1	4.5	26	i	
1976 Jan 01	0032	66.10-16.76	2	4.48		1	4.8	58	e	
1976 Jan 04	0429	66.09-16.70	6	4.81	1	13	5.2	119	e	
1976 Jan 06	0850	65.75-16.79	28	4.35	1	6	4.9	104	e	

Table 2.1 – Cont.

Date	OT (GMT)	Epicentre	h	M_S	S	n	m_t	N	A	M
1976 Jan 06	2301	66.09-16.73	26	4.5		1	4.7	50	e	
1976 Jan 09	0346	66.06-16.72	1	4.72	3	3	4.8	84	e	
1976 Jan 09	0645	65.95-16.74	8	4.6		1	4.7	65	e	
1976 Jan 13	0434	66.09-16.92	1	5.0		7	5.0	97	e	
1976 Jan 13	1329	66.28-16.57	4	6.33	2	16	5.9	353	e	
1976 Jan 13	1626	66.09-16.67	9	4.5		1	4.7	50	e	
1976 Jan 14	0905	65.73-16.71	10	3.8		1	4.5	31	i	
1976 Jan 15	0016	66.14-16.72	10	3.8		1	4.5	21	i	
1976 Jan 17	1151	65.68-17.00	15	3.9		1	4.5	50	e	
1976 Jan 18	0823	65.69-16.95	10	4.48	1	4	4.7	62	e	
1976 Jan 19	0922	65.69-16.95	17	4.90	2	12	4.9	107	e	
1976 Jan 20	0445	65.70-16.79	9	4.0		1	4.6	37	e	
1976 Jan 21	1432	65.74-16.77	10	4.7		5	4.7	71	e	
1976 Jan 22	2056	65.78-16.71	n	3.8		1	4.5	26	i	
1976 Jan 31	2240	65.64-16.90	10	4.72	1	12	4.7	72	e	
1976 Feb 02	1316	66.10-16.74	1	4.81	2	16	4.8	115	e	
1976 Mar 06	2027	66.57-17.89	1	4.71	0	3	4.6	90	e	
1976 Jul 27	0401	64.69-17.38	1	5.00	2	12	5.1	228	e	
1977 Jan 20	0257	65.70-16.80	5				4.2	18	r	
1977 Jan 20	0434	65.74-16.83	10				4.2	27	i	
1977 Mar 24	0925	63.65-19.10	5				4.7	25	r	
1977 May 16	1648	63.91-22.31	8	4.81	2	18	4.6	67	e	
1977 May 16	1658	63.96-22.00	10	4.9		1	4.0	21	i	
1977 Jun 02	1455	63.63-19.18	1	5.10	2	29	4.9	172	e	
1977 Jul 01	1831	64.61-17.80	5	3.97		1	3.8	25	i	
1977 Jul 14	0715	64.46-17.57	29	4.5		1	4.8	72	e	
1977 Dec 28	2032	64.63-17.38	1	5.05	3	18	5.2	190	e	
1978 Jan 09	0915	65.91-16.99	1	4.18		1	4.3	31	e	
1978 Jan 09	1354	65.95-16.98	10	4.39	2	2	4.4	34	i	
1978 Jan 09	1903	65.97-16.89	6	4.66	2	4	4.6	59	i	
1978 Jan 09	2002	65.98-17.00	13	3.83		1	4.2	30	i	
1978 Jan 10	0156	65.98-17.00	10	4.27		1	4.2	27	i	
1978 Jan 10	1039	66.01-16.80	10	3.63		1	4.1	17	i	
1978 Jan 10	1245	65.94-16.64	15	3.83		1	4.5	49	e	
1978 Jan 10	1742	65.98-17.00	10	4.65	2	7	4.8	61	e	
1978 Jan 10	1925	66.03-16.80	10	3.56		1	4.3	22	i	
1978 Jan 10	2045	65.89-16.88	7	4.6		1	4.7	54	e	
1978 Jan 11	1058	65.95-16.91	9	4.40	1	3	4.8	79	e	
1978 Jan 13	0031	66.01-16.94	3	4.00	3	3	4.7	34	e	
1978 May 3	2359	64.73-17.40	10				3.9	22	i	
1978 May 17	0943	62.76-25.30	10				4.2	24	i	
1978 Jun 21	2329	64.64-17.60	n				4.0	29	i	
1978 Jul 12	1759	66.05-16.80	n				4.0	27	r	
1978 Sep 06	1923	64.45-18.20	10	3.99		1	4.0	27	i	
1979 Apr 1	0431	64.51-17.60	5	3.10		1	4.0	36	i	
1979 Apr 30	2328	66.53-17.95	10	3.59		1	4.2	43	i	

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1979 Jun 22	2318	64.53-17.55	7	4.94	3	48	5.4	282	e	
1980 May 05	1322	64.51-17.50	10	3.05		1	4.0	23	i	
1980 May 17	2115	63.15-24.49	10	3.85		1	4.5	48	i	
1980 Aug 12	1211	64.69-17.33	26	5.14	2	41	5.3	242	e	
1980 Aug 20	1425	62.70-25.33	20	4.52	3	17	4.8	130	e	
1980 Aug 20	1506	62.70-25.28	9	4.54	2	14	4.4	82	e	
1980 Dec 25	1137	66.51-17.68	12	4.77	1	18	5.2	168	e	
1980 Dec 25	1144	66.56-17.74	10	3.87		1	4.6	46	e	
1980 Dec 25	1157	66.63-17.38	10	3.40		1	4.5	12	i	
1980 Dec 25	1747	66.47-17.77	10				4.7	37	e	
1980 Dec 26	0045	55.50-17.86	10	3.11		1	4.5	23	i	
1980 Dec 26	0146	66.39-18.17	10	3.60		1	4.5	23	i	
1980 Dec 26	0501	66.38-18.04	12	3.85		1	4.5	27	i	
1980 Dec 26	0503	66.48-17.84	8	4.34	4	3	4.8	55	e	
1981 May 09	0131	64.58-20.90	10				4.4	20	i	
1981 Jul 12	1806	62.94-25.10	10				4.2	23	i	
1982 Nov 08	1243	62.70-24.55	1	4.43	3	7	4.6	55	e	
1982 Nov 08	1637	63.20-25.70	10				4.6	20	i	
1983 Apr 06	1358	61.80-25.60	10	4.50	2	3	4.5	66	i	
1983 Apr 06	1414	62.47-25.89	6	4.4		1	4.8	89	e	
1983 May 16	1535	63.51-23.74	1	4.55	2	6	4.6	67	e	
1983 May 16	1542	63.52-23.48	5	4.81	2	19	4.9	121	e	
1983 Jul 11	1942	63.47-23.90	4	4.12	2	2	4.6	59	e	
1983 Jul 11	2026	63.36-23.91	1	4.69	2	6	4.7	78	e	
1983 Jul 20	0944	64.46-17.81	10	4.59	0	2	4.6	48	i	
1984 Feb 22	1830	64.35-20.60	10	4.0		1	4.5	41	i	
1984 Apr 24	0822	62.97-24.89	15	4.46	2	10	4.7	101	e	
1984 Sep 30	2332	64.56-17.55	3	4.77	2	43	5.2	244	e	
1984 Nov 10	0840	61.78-29.21	10	5.02	3	38	5.0	225	i	
1985 Jan 13	2115	63.09-24.40	10				4.3	25	i	
1985 Feb 20	1510	62.81-25.04	10	4.0		1	4.6	63	e	
1985 Jun 25	1031	64.61-20.78	8	4.60	2	20	4.4	82	e	
1985 Jun 26	1339	64.67-20.80	10	3.93	2	4	4.3	54	i	
1985 Jun 28	1644	64.53-20.90	3	3.69	0	2	4.3	41	i	
1985 Jul 01	0014	61.20-25.60	10				4.1	25	i	
1985 Jul 19	1723	64.00-21.60	n				4.2	22	r	
1985 Aug 30	1847	67.71-19.01	10	4.36	2	8	4.6	28	i	
1985 Aug 30	1901	67.65-18.88	15	4.71	1	19	5.0	129	e	
1985 Dec 24	1052	67.73-18.70	10	4.02	1	2	4.6	38	i	
1986 Apr 02	0841	62.63-25.37	10	4.47		1	4.6	68	e	
1986 Apr 02	0844	62.81-25.21	7	4.1		1	4.6	65	e	
1986 Apr 02	0846	62.69-25.28	10	4.89	3	28	5.0	191	e	
1986 Apr 02	0849	62.60-25.20	10				4.3	24	i	
1986 Apr 02	0859	62.73-25.27	8	4.60	1	10	4.8	121	e	
1986 Apr 02	1526	62.66-25.36	5	4.78	2	31	5.2	271	e	
1986 Apr 02	1740	62.60-25.44	6	4.59	3	5	4.8	126	e	

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1986 Apr 02	1749	62.65-25.29	12	5.00	2	38	5.1	264	e	
1986 Apr 02	1802	62.60-25.27	10	3.8		1	4.5	33	e	
1986 Apr 02	2035	62.40-25.70	n	3.68		1	4.2	32	i	
1986 Aug 03	0137	62.47-25.81	9	4.0		1	4.6	43	e	
1986 Sep 16	1418	63.36-24.05	n	4.39	4	6	4.5	37	i	
1986 Oct 12	2334	66.21-17.43	n	3.71	3	2	4.2	39	i	
1986 Oct 21	0859	61.80-25.70	n	3.7		1	4.5	24	i	
1986 Nov 23	0249	64.65-17.35	7	5.12	2	6	5.2	244	e	
1987 May 25	1132	63.91-19.79	8	5.95	2	58	5.7	483	m	
1987 Jul 01	1756	64.72-17.67	7	3.64	0	3	4.3	65	e	
1987 Sep 16	0237	66.53-18.30	n				4.3	26	i	
1988 Sep 09	1441	66.59-18.09	3	4.22	3	5	4.4	55	e	
1988 Sep 12	2019	66.64-17.84	6	4.55	2	30	4.7	186	m	
1988 Sep 12	2300	66.60-18.40	n	3.41		1	4.2	25	i	
1989 Feb 03	1440	64.64-17.50	n				4.1	26	i	
1989 Feb 03	1518	64.56-17.43	2	4.95	3	13	5.2	350	e	
1989 May 06	2346	64.70-17.45	n	4.26	1	2	4.3	20	i	
1990 Mar 19	1046	63.95-21.93	6	4.68	1	19	4.7	138	m	
1990 May 26	0256	63.00-24.72	19	4.23	3	5	4.5	57	e	
1990 May 30	0612	62.80-25.50	n				4.2	37	i	
1990 Sep 15	1752	63.81-22.48	n	4.00	2	5	4.3	50	i	
1990 Sep 15	2307	64.65-17.60	21	5.34	3	96	5.3	333	e	
1990 Oct 30	1230	63.03-24.56	1	4.63	2	14	4.8	67	e	
1990 Oct 30	1254	63.08-24.66	5	4.00	0	2	4.6	28	i	
1990 Oct 30	1307	63.38-24.11	10	4.28	1	4	4.8	46	e	
1990 Oct 30	1336	62.96-24.14	5	4.20	1	4	4.8	28	i	
1990 Oct 30	1358	63.26-24.34	10	4.33	1	8	4.9	55	e	
1990 Oct 30	1403	63.16-24.29	3	4.55	1	12	4.9	94	e	
1990 Oct 30	1547	63.32-24.06	5	4.38	0	2	4.7	16	i	
1990 Oct 30	1916	63.22-24.23	13	4.36	1	7	4.8	77	e	
1990 Oct 30	2123	63.28-24.21	10	4.62	2	12	4.7	46	e	
1990 Oct 30	2310	63.18-24.33	5	3.72	1	2	4.6	23	i	
1990 Oct 30	2348	63.13-24.41	n	3.86	0	3	4.7	32	i	
1990 Oct 31	0051	63.21-24.16	10	4.39	2	10	4.9	76	e	
1990 Oct 31	0344	63.08-24.78	5	4.14	1	4	4.7	29	i	
1990 Oct 31	0400	63.32-24.66	5	4.05	0	3	3.7	28	i	
1990 Oct 31	0450	63.14-24.63	10	3.88	0	3	4.7	27	e	
1990 Oct 31	0552	63.24-24.55	5	3.79	1	2	4.7	14	i	
1990 Oct 31	0623	63.23-23.93	5	3.73	1	2	4.7	21	i	
1990 Oct 31	0658	63.28-24.23	15	3.87	0	2	4.7	56	e	
1990 Oct 31	0839	63.26-24.30	5	3.52		1	4.6	20	i	
1990 Nov 03	1426	63.60-24.00	n	3.67	0	4	4.3	25	i	
1990 Nov 05	1720	63.09-24.17	10	3.88	1	4	4.3	34	e	
1990 Dec 29	0257	68.40-18.20	10				4.8	30	i	
1991 Jan 30	0743	64.38-20.75	19	4.77	2	26	5.1	145	m	
1992 Apr 25	0648	64.65-17.39	9	4.67	3	21	4.8	232	e	

Table 2.1 – Cont.

Date	*OT(GMT)*	*Epicentre*	*h*	M_S	*S*	*n*	m_b	*N*	*A*	*M*
1992 Sep 26	0545	64.66-17.60	9	5.38	2	128	5.4	382	e	
1992 Dec 27	1223	64.00-21.20m	3	3.73	1	4	4.3	35		
1993 Jun 22	1233	64.71-17.30	7	4.96	2	88	5.1	257	e	
1993 Aug 28	1959	65.97-17.94	15				4.1	33	m	
1994 Feb 08	0327	66.47-19.25	17	5.46	2	103	5.2	358	e	
1994 May 05	0514	64.52-17.52	9	5.28	2	106	5.5	460	e	
1994 May 31	2323	68.10-20.60	n				4.2	24	i	
1994 May 31	2355	67.40-19.80	n				3.9	20	i	
1994 Jul 22	0045	64.78-21.60	n				4.1	23	i	
1994 Aug 20	1640	64.03-22.34	10				4.2	27	m	
1994 Nov 18	2354	64.39-18.90	10				4.2	27	i	
1994 Dec 20	2351	68.67-17.50	6				4.5	43	i	
1995 Feb 02	1521	62.41-25.49	11	4.0		4	4.5	89	e	
1995 Nov 18	0156	64.70-17.40	10	3.7		2	4.2	48	e	
1995 Dec 11	0522	64.59-17.74	10	4.39	2	12	4.9	171	e	

Key to Table 5.1.

Col.	*Symbol*	*Explanations*
1+2+3	Date	Year, month and day.
4	OT(GMT)	Origin time in hours and minutes (Greenwich Mean Time).
5	Epicentre	Epicentral location in geographical coordinates, °N-°W, calculated by agency shown in column 12 (m = macroseismic; r = relocated).
6	h	Hypocentral depth in km (n = not available).
7	M_S	Recalculated surface-wave magnitude from Prague formula corrected for distance (see Ambraseys & Free [1997]), * indicates values obtained from Milne instruments.
8	S	Standard deviation of recalculated surface-wave magnitude, M_S (0 = 0-0.09; 1 = 0.10-0.19, 2 = 0.20-0.29, etc).
9	N	Number of stations used in calculation of M_S. 00 indicates that the shock was not reported as recorded in ISS bulletins or found in bulletins of stations within 20° from Iceland.
10	m_b	Body-wave magnitude calculated by ISC; * indicates magnitudes calculated in this study and obtained from long period body-waves.
11	N	Number of stations used in the BAAS / ISS / ISC for the determination of epicentres.
12	A	Agency responsible for epicentral location; b = Strasbourg; e = Engdahl et al. [1998]; i = BAAS / ISS / ISC; K = Karnik [1968]; s = Sykes [1965]; u = USCGS / NEIC.
13	M	Surface-wave magnitude calculated by other researchers (A = Abe [1981, 1994], K = Karnik [1968]).

Table 5.2 - Magnitudes and seismic moments for selected earthquakes.

	Date			GMT	Epicentre	h	M_S	$\log(M_o)$
1	1977	Dec	28	2032	64.63-17.38	1	5.05	24.15
2	1979	Jun	22	2318	64.53-17.55	7	4.94	23.86
3	1980	Aug	12	1211	64.69-17.33	26	5.14	24.28
4	1980	Dec	25	1137	66.51-17.68	12	4.77	23.63
5	1984	Nov	10	0840	61.78-29.21	10	5.02	23.99
6	1985	Aug	30	1901	67.65-18.88	15	4.71	23.76
7	1986	Apr	02	0846	62.69-25.28	10	4.89	23.97
8	1986	Apr	02	1749	62.65-25.29	12	5.00	24.04
9	1987	May	25	1132	63.91-19.79	8	5.95	25.04
10	1989	Feb	03	1518	64.56-17.43	2	4.95	23.69
11	1990	Sep	15	2307	64.65-17.60	21	5.34	24.45
12	1990	Oct	30	1403	63.16-24.29	3	4.55	23.45
13	1991	Jan	30	0743	64.38-20.75	19	4.77	23.90
14	1992	Sep	26	0545	64.66-17.60	9	5.38	24.51
15	1993	Jun	22	1233	64.71-17.30	7	4.96	24.00
16	1994	Feb	08	0327	66.47-19.25	17	5.46	24.36
17	1994	May	05	0514	64.52-17.52	9	5.28	24.20

Note: M_S denotes recalculated surface-wave magnitude; M_o is the CMT seismic moment in dyn·cm.

6. CASE HISTORIES

In the following, we present the macroseismic information collected from material available in books, periodicals, newspapers and public domain reports. The main sources of earthquakes in the period before 1900 are furnished in Thoroddsen's pioneering works [Thoroddsen, 1898, 1899, 1901, 1925]. The first decades after 1900 are covered by Thoroddsen [1925], Harboe [1913, 1914, 1915], Tams [1910] and Sieberg [1920]. Furthermore, the report of Ottósson [1980] has been of value. The period from 1930 to 1959 is dealt with by Tryggvason in his reports [1978a, 1978b, 1979]. Various local newspapers have been very useful sources of information for the whole period. Furthermore, the macroseismic descriptions for the period from 1960 to present are mostly based on a newspaper survey, where the following newspapers have been especially consulted: *Morgunbladid*, *Tíminn* and *Thjódviljinn* as well as *Althýdubladid*. The following reports have also been quite useful: *Skjálftabréf*, issued by the Science Institute, University of Iceland, and the Icelandic Meteorological Office for the period 1975 to 1988; *Mánadaryfirlit jardskjálfta*, issued by the Icelandic Meteorological Office and the Science Institute, University of Iceland, for the period 1987 to 1990. Finally, the works of Björnsson [1975] and Björnsson and Einarsson [1974, 1981] have been of great value. At the end of each case description, the main source relied upon is indicated in brackets, but not necessarily all the publications consulted.

In the following text, many local names inevitably have to be included. The spelling of these Icelandic names is kept in accordance with current Icelandic rules with the exception of the special Icelandic characters Þ, þ and Ð, ð. The character Þ (þ), named thorn, is always used as an initial letter. It is equivalent to 'th' (as in thing) and is written herein as th. The character Ð (ð) is never used as an initial letter. It is approximately equivalent to a hard 'dh' (as in this) and is written herein as d.

Descriptive catalogue of earthquakes 1896 to 1996

Each case is identified in accordance with Table 5.1 (see page 28 and 37) to make it easier to relate the qualitative description to the quantitative one without going back to Table 5.1. We have in the available cases listed assessed intensities or indicated 'word or phrases' reflecting intensities. These intensities are in accordance with the MMI scale (the 1940 version) if not otherwise stated.

`1896 Aug 26 2320 63.97-20.20m n 6.62 3  9                 6.5A`

This was the first shock of a series of destructive earthquakes in the South Iceland Lowland occurring in August and September 1896. The damage induced by these earthquakes is described in detailed, contemporary field reports [Newby, 1896; Thoroddsen 1899, 1900 and 1901]. This is the first earthquake in Iceland for which we have teleseismic data from primitive seismographic stations in Russia and Italy, the only ones in operation at that time.

The earthquake struck at 23h 20m (GMT) without any warning or clear precursor. The earthquake was felt over the whole southern part of Iceland from Hornafjördur in the East to Reykjanes in the West (see Figure 6.1). In Reykjavík the earthquake is described as two subsequent shocks occurring almost without any interval. The earthquake was rather strong in the beginning; then it fell off before increasing again to an intensive shaking towards the end. People ran out of houses; small house articles fell off shelves or toppled, and a few chimneys were damaged. The earthquake was also felt in West Iceland, on the islands of Breidafjördur and up to the village of Ísafjördur, where people sensed two mild earthquakes. The earthquake was felt in the western part of North Iceland. In Hrútafjördur, people woke up when the earthquake struck. People on some farms in Vatnsdalur felt it mildly. On the other hand, the earthquake was not felt in Skagafjördur, and there is no information that the earthquake was felt in the north-east part of Iceland or in the East Fjords. The effects of the earthquake on the mountainous inland were slight. The effects at Veidivötn (Fiskivötn) are described as mild [Thoroddsen 1899, p. 69].

The effects of the earthquake on South Iceland were most destructive on Rangárvellir, Land, Holt and Gnúpverjahreppur. On Land, houses on 28 of 35 farms collapsed into ruins, and the rest were severely damaged. An overview of the number of collapsed houses is given in Table 6.1, while the destruction zone is indicated in Figure 6.2. In several locations, large ground deformations, fissures in the soil and fractures in the bedrock were observed. On the grass grown Skardsfjall, the soil layer loosened from the bedrock in several places and slid downhill. The largest surface fault on Land (see Figure 6.2) was about 15 km long according to Thoroddsen [1899]. Site investigations today have indicated that the surface fault is shorter than this, probably no more than 7 km [see for instance Geology map of Iceland, 1998].

[Thoroddsen, 1899]

1896 Aug 27 1047 64.13-20.25m n 6.12 3 5 6.2A

The next morning, new damaging earthquakes struck. The effects of the first one were greatest in Land and Gnúpverjahreppur but farther north than in the earthquake the evening before (see Figure 6.3). The motion in Land was so great that people could not stand. The damage was considerable, and a few buildings, already damaged, collapsed totally.

The second earthquake struck, at the 'same time', in the Vestmannaeyjar (Westman Islands). This earthquake caused a lot of rock fall from the steep cliffs, resulting in one person's being killed.

[Thoroddsen, 1899]

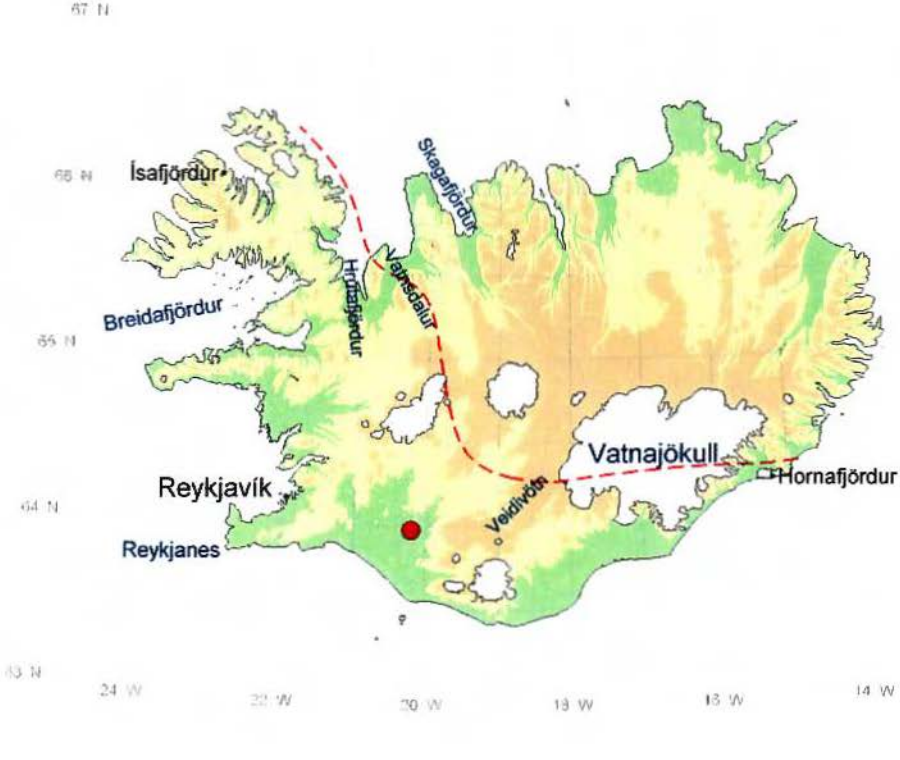

Figure 6.1 – Map indicating the macroseismic epicentre of the earthquake on 26 August 1896 (the red spot) and locations in distant regions where shaking was reported. The dashed red line indicates roughly the felt area as defined by Thoroddsen [1899, 1901]. Note that the distance between the meridians at 63° parallel is ~50.5 km.

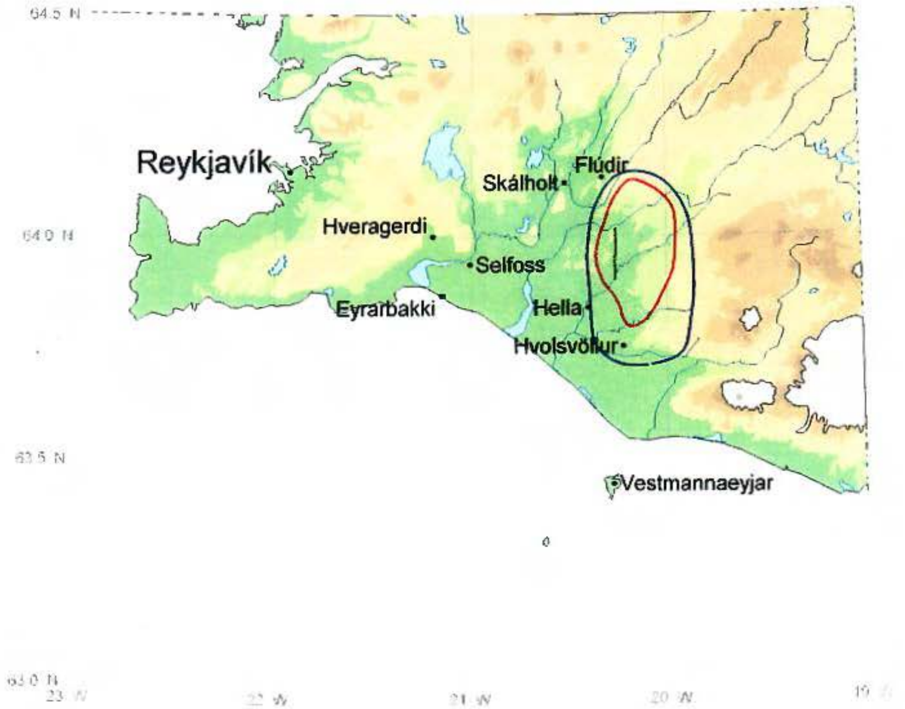

Figure 6.2 – The meizoseismal region of the earthquake on 26 August 1896. The following notation is used:— curve encircling the most severely affected area; — curve encircling the destruction zone where more the 50% of houses collapsed; — line indicating major surface faults. Based on Thoroddsen [1899] and Björnsson and Einarsson [1981]. Villages in the area today are indicated. Note that the distance between the meridians at 63° parallel is ~50.5 km.

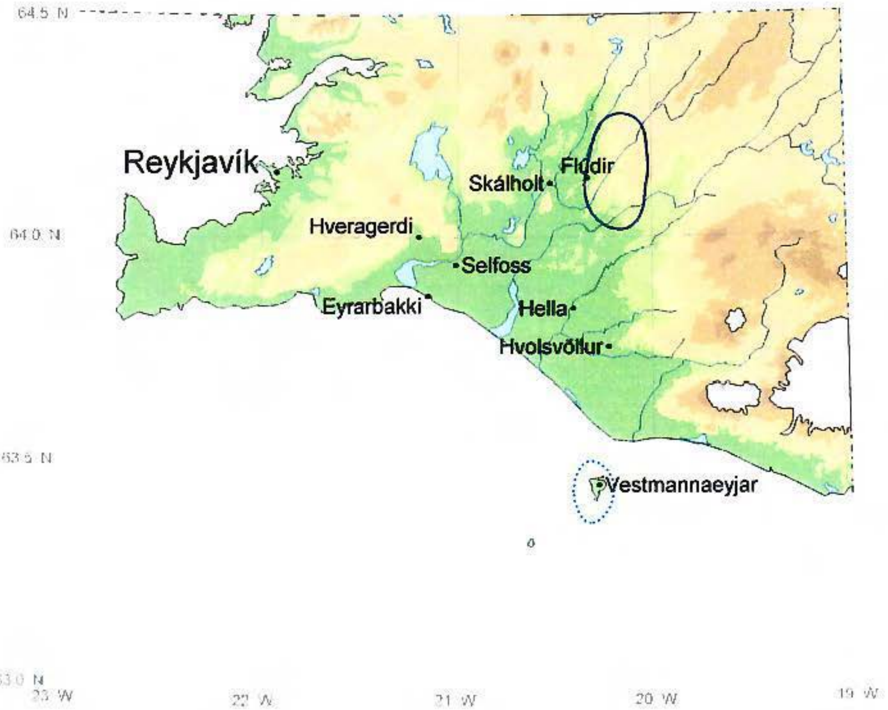

Figure 6.3 – The meizoseismal region of the earthquakes on 27 August 1896. — indicates the most severely affected areas. Based on Thoroddsen [1899] and Björnsson and Einarsson [1981]. Villages in the area today are indicated.

1896 Sep 05 2357 63.98-20.70m n 6.35 2 6 6.5A

On the evening the 6 September, destructive earthquakes shook South Iceland again. The effects were greatest in Skeid, Holt and Flói. The macroseismic epicentre of the first shock was close to Selfoss. The second shock (occurring about one minute after the first shock [Thoroddsen, 1899]) had a macroseismic epicentre about 25 km east of Selfoss.

An 80-m-long suspension bridge over the Ölfusá River at Selfoss was severely damaged. Many houses collapsed (see Table 6.1). Two people in Selfoss were killed in a collapsing house. The rockfall in nearby mountains was quite considerable, especially on Mt. Ingólfsfjall north of Selfoss. The ground deformations and dislocations were considerable. The largest surface fault was at Skeid (see Figure 6.4).

These earthquakes were followed by many small aftershocks.

[Thoroddsen, 1899]

Table 6.1 - Overview of collapsed houses in the 1896 South Iceland Lowland Earthquakes (based on Thoroddsen [1899]).

Date of earthquakes	*Number of collapsed houses*1)		
	Farm-houses	*Out-houses*	*Total*
August 26	517	1326	1.843
August 27	64	89	153
September 5	482	686	1.168
September 6	207	232	439
September 10	39	50	89
Total number of collapsed houses	1.309	2.383	3.692
Total number of houses	7.748	11.090	18.838

1) The majority of farmhouses were traditionally Icelandic, made of turf and stone and having a roof system supported by wooden rafters. At each farm, as a rule, the houses were partly arranged in a compact cluster and partly scattered around (the outhouses) over the surrounding '*tún*' (hayfield) (see for instance Nilsson [1939]). A small fraction of the houses were wood-frame houses. They resisted the earthquakes much better than the traditional houses (see Thoroddsen [1899]).

1896 Sep 06 63.98-21.20m n 0

During the night of 6 September, the fifth major destructive earthquake hit South Iceland. The effects were greatest in Ölfus where houses on 24 farms collapsed into ruins (see Figure 6.5). No one was injured as the people were sleeping outdoors in tents.

[Thoroddsen, 1899]

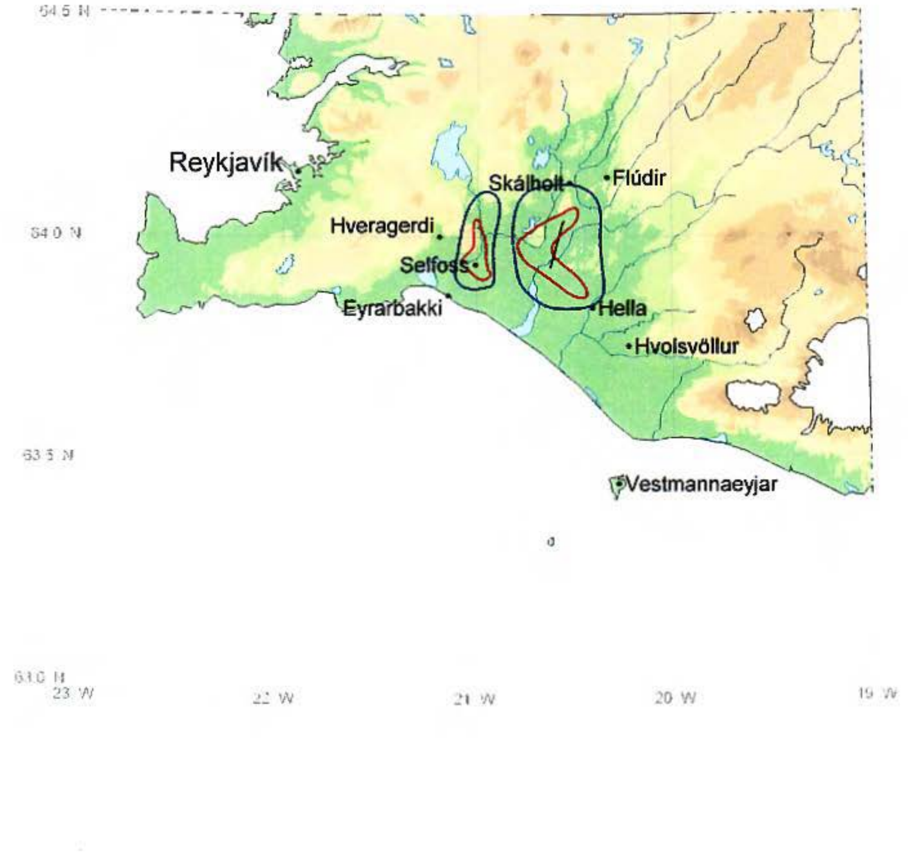

Figure 6.4a – The meizoseismal region of the earthquakes on 5 September 1896. The following notation is used: — curve encircling the most severely affected areas; — curve encircling the destruction zone where more the 50% of houses collapsed; — line indicating major surface faults. Based on Thoroddsen [1899] and Björnsson and Einarsson [1981]. Villages in the area today are indicated.

Figure 6.4b – The ruins of traditional Icelandic farmhouses at Selfoss. The photo was taken after the earthquake on 5 September 1896 [Thoroddsen, 1925].

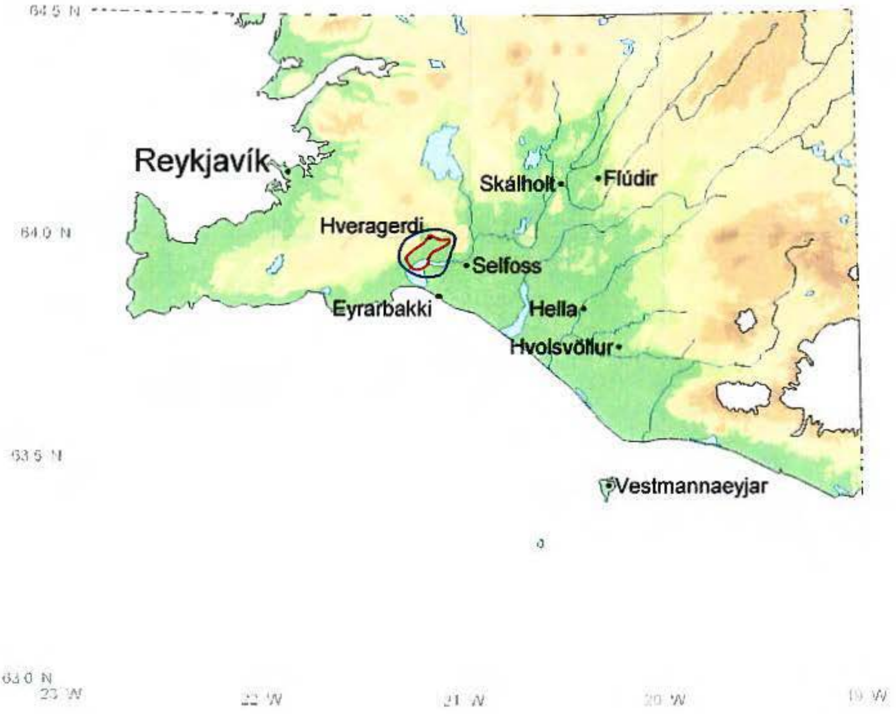

Figure 6.5a – The meizoseismal region of the earthquake on 6 September 1896. The following notation is used: — curve encircling the most severely affected area; — curve encircling the destruction zone where more the 50% of houses collapsed. Based on Thoroddsen [1899] and Björnsson and Einarsson [1981]. Villages in the area today are indicated.

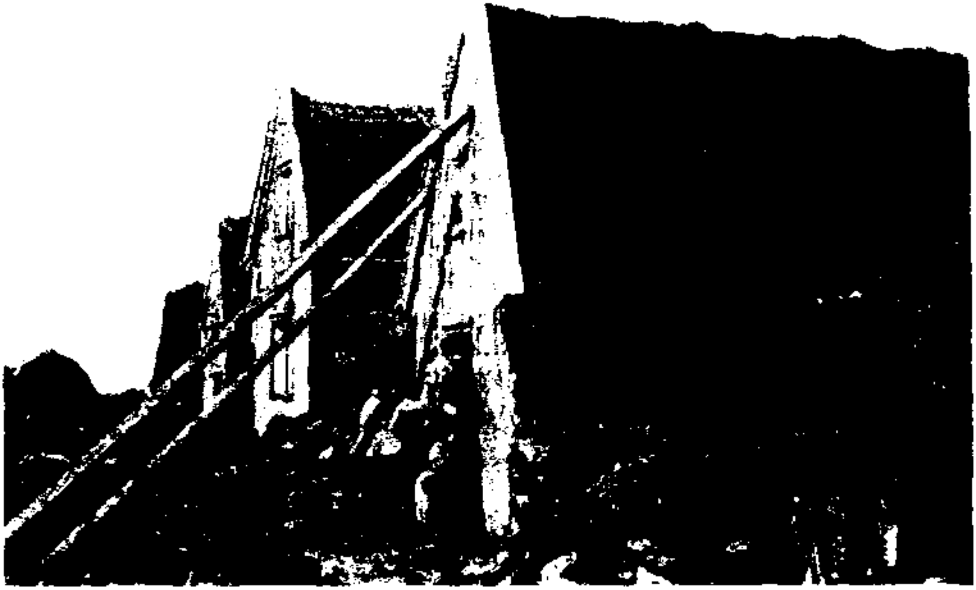

Figure 6.5b – Earthquake induced damage of traditional Icelandic farmhouses at Arnarbæli in Ölfus. The photo was taken after the earthquake on 6 September 1896 [Thoroddsen 1925].

1896 Sep 10 63.95-20.85m n 0

On 10 September, the sixth and last destructive earthquake in the earthquake series that started on 26 August occurred. The damage was greatest in Flói, east of Selfoss (see Table 6.1 and Figure 6.6).

In the months to come, there were a lot of small aftershocks.

[Thoroddsen, 1899]

1899 Jan 31 1112 66.30-19.90m n 5.77 - 1

This earthquake was felt along the North Coast of Iceland from Bordeyri to Akureyri and on the West Coast at Ísafjördur and at Holt in Önundarfjördur. At Skagaströnd, house articles tumbled and fell off the shelves, and porcelain was broken. In Saudárkrókur, houses were shaken violently, but not damaged. Ice on Lake Miklavatn in Skagafjördur broke, and the water 'spouted' up through cracks, 2-3 feet high. The earthquake was also felt in Grímsey. Figure 6.7 shows a tentative map of isoseismals.

[Thoroddsen, 1925; *Fjallkonan* 1899; *Ísafold* 1899; *Thjódólfur* 1899; *Thjódviljinn* 1899]

1899 Feb 23 1336 63.50-23.50m n 5.7* 2 4

An earthquake, not felt at Reykjanes, had its epicentre on the Reykjanes Ridge towards the Southwest.

1899 Feb 26 1336 64.50-23.00m n 5.7* 2 2

This shock was felt at Mýrar, on the farm Álftanes.

[Thoroddsen, 1925; *Fjallkonan* 1899; *Ísafold* 1899; *Thjódólfur* 1899; *Thjódviljinn* 1899]

1899 Feb 27 1117 63.95-22.80m n 6.03 - 1

A shock from an earthquake swarm offshore at Reykjanes. The shock was felt at the lighthouse at Reykjanes, at Hafnir in Keflavík and at Mýrar (Álftanes). A traditional house in Hafnir collapsed during this swarm.

[Thoroddsen, 1925; *Fjallkonan* 1899; *Ísafold* 1899; *Thjódólfur* 1899; *Thjódviljinn* 1899]

1899 Feb 27 1521 63.80-22.80m n 5.95 - 1

An earthquake felt very strongly at the Reykjanes lighthouse. The chimney on the house broke and fell down; the stove upstairs toppled; the stoves downstairs slid around; house articles fell, and a book 'cabinet' toppled. The foundation wall of the house (the east wall) cracked at the corners, and the stonewall, surrounding the infield, fell down. There was also threatening rock-fall from the

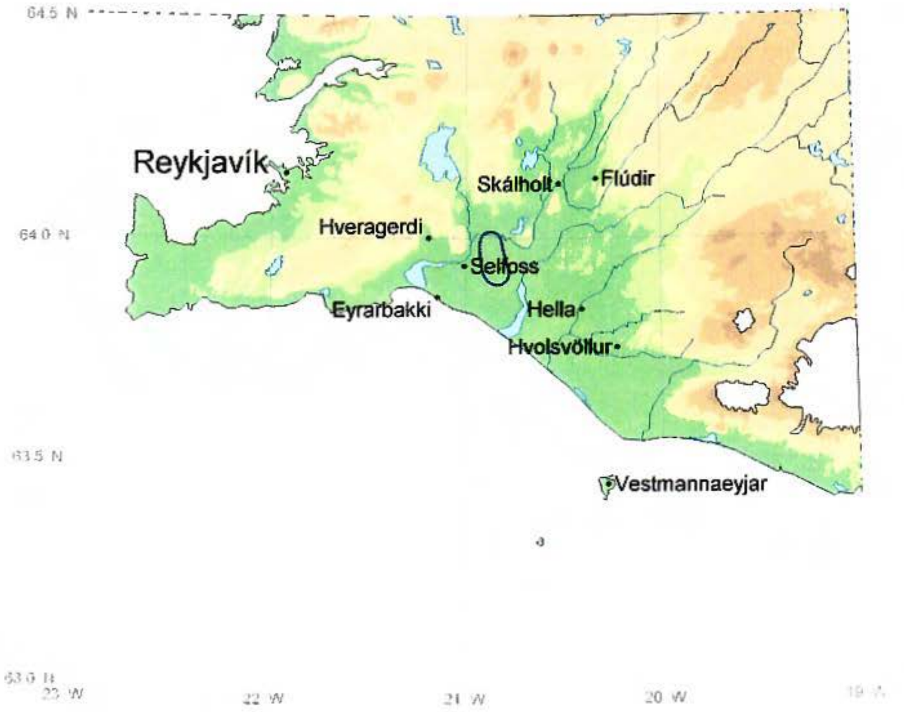

Figure 6.6 – The meizoseismal region of the earthquake on 10 September 1896. — indicates the most severely affected areas. Based on Thoroddsen [1899] and Björnsson and Einarsson [1981]. Villages in the area today are indicated.

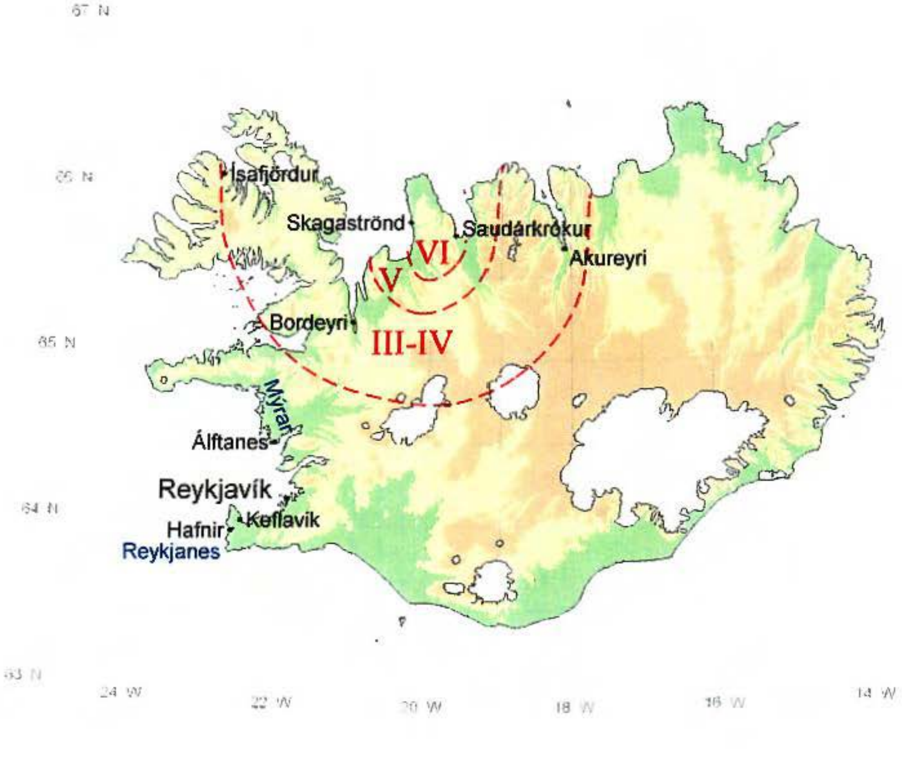

Figure 6.7 – Tentative isoseismals of the earthquake on 31 January 1899. Included are a few names of settlements where this earthquake and others in 1899 were felt (see the main text). Based on Thoroddsen [1905, 1925] and contemporary newspapers.

nearby 'moutain'. This earthquake was also felt in Reykjavík.

[Thoroddsen, 1925; *Fjallkonan* 1899; *Ísafold* 1899; *Thjódólfur* 1899; *Thjódviljinn* 1899]

1904 Jun 15 24-- 64.00-20.00m n 0 4.6K

An earthquake was felt in Landssveit on the South Iceland Lowland. The earthquake is described as very strong. People woke up, and buildings emitted cracking sounds. Small standing objects moved and even toppled; hanging objects quivered.

[Harboe, 1910]

1904 Aug 02 1012 66.30-18.70 n 5.59 1 4

The shock was felt at Siglufjördur, where the effects of the earthquake were described as 'strong'. The (wave-induced) rolling of the ships (in the harbour) was critical. In Akureyri the effects were moderate. Standing water waves (in glasses) were observed, and there were cracking sounds in buildings and clinking of glasses. At Saudárkrókur, the effects were barely perceptible. No damage was reported.

[Ottósson, 1980].

1905 Jan 28 0618 63.95-22.00m n 5.6K

A series of earthquakes were felt in the settlements on the Reykjanes Peninsula and on the South Iceland Lowland. The farm houses in Krísuvík were damaged. The strongest shock occurred, probably, at 06:52 on 28 January, and it was felt in Reykjavík but not at the Reykjanes lighthouse.

We can find no teleseismic data for this event.

[Harboe, 1913; Ottósson, 1980].

1905 Nov 15 0650 66.20-18.00m n 5.49 4 3 5.1K

The earthquake was strongest in Akureyri. People woke up; buildings emitted cracking sounds, and porcelain clinked. The shock was felt as far as Holt (in Önundarfjördur) and Ísafjördur.

[Harboe, 1913; Ottósson, 1980]

1905 Nov 19 2335 64.00-20.00 n 5.36 - 1

This earthquake was recorded at stations on both sides of the Atlantic, and its general location was in the region of Iceland. It could have been an aftershock of the earthquake on 15 November. No macroseismic information is available.

[Harboe, 1913]

It is worth mentioning in this context that earthquakes struck in South Iceland in November. These earthquakes were so strong that the people on the farm Næfurholt (approximate location 64.0°N 20.0°W) next to Mt. Hekla temporarily left the farm. The macroseismic epicentre is probably near Hekla, but the exact date of these events is not available.

[*Ingólfur*, Nov. 26, 1905]

1906 Jan 13 19-- 63.90-20.00m n 0 4.6K

A strong earthquake in Rangarvellir caused some panic but no damage. It is described as the strongest earthquake in this area since the great earthquakes in 1896. However, it was not reported in other parts of the island, and we could find no teleseismic data for it; thus, it was probably a local event.

[Ottósson, 1980]

1906 Mar 19 0757 68.70-17.00 n 6.62 1 5 *6.7 5.9K

This earthquake of relatively large magnitude was well recorded. Szirtes [1910] locates it at 68.7° N and 17.0° W, about 200 km north of Iceland, and BAAS at 70.0° N and 9.0° W, just south of Jan Mayen Island. A relocation by Tams [1919] places the earthquake further north at 73.8° N and 9.1° W, 800 km NNE of Iceland and 300 km north of Jan Mayen.

There are no reports from Iceland of this earthquake being felt, which occurred outside the study area

[Harboe 1913; Szirtes 1910; Tams 1919]

1906 Nov 9 0220 66.20-18.00m n 4.68 2 4 4.6K

This earthquake was preceded and followed by other small shocks. In Akureyri the main shock occurred at 01h 20m local time. People woke up, and some went outdoors. No damage was reported. It was perceptible in Vopnafjördur.

[Harboe, 1913]

1908 Oct 14 1800 63.90-23.00m n 4.6K

At 17h local time, a strong shock caused some damage to the Reykjanes lighthouse. Many small shocks followed.

Not recorded at Disco Island or any other station.

[Harboe, 1913]

1908 Dec 26 0704 66.20-18.00m n 5.03 0 2 4.6K

A strong earthquake was felt in Akureyri, where people woke up. Six shocks merged into one earthquake that was most intensive at the start and towards the end.

[Harboe, 1910 and 1913]

1909 Feb 23 0430 64.00-20.10 0

A sharp shock was felt in Stórinúpur at 03h 30m local time. We could find no instrument records for this event.

[Harboe, 1915; Ottóson, 1980]

1910 Jan 22 0848 66.50-17.50m n 7.19 3 14 *7.1 7.0A

A large earthquake was felt over most of Iceland from Ísafjördur in the West to Fáskrúdsfjördur in the East, and from Reykjavík and farms on the South Iceland Lowland to the Raufarhöfn in the North. The intensity of the earthquake was greatest in the north-eastern part of Iceland. An Icelandic newspaper published in Akureyri [*Nordri*, 28 January 1910] described the earthquake as follows: '28 January at about 7:30 (local time), people felt a small earthquake. Then a big earthquake followed, shaking houses violently and cracking the ice in the harbour. This is the strongest earthquake in this area since 1872. In the days following, there were a lot of smaller earthquakes.' However, no damage was reported. Figure 6.8 shows an isoseismal map of the earthquake, based on data reported by Harboe [1913] and collected under the auspices of Th. Krabbe.

[Harboe, 1913, 1915; Sieberg, 1932; Tams, 1910, 1919, 1927]

1910 Jan 22 1045 63.85-23.00m n 5.1K

A small earthquake was felt in Reykjavík. Local newspapers reported more than one shock.

[Ottósson, 1980]

1912 May 06 1859 63.98-19.83m n 7.05 3 18 *6.9 7.0A

A great destructive earthquake was felt over a large part of Iceland. The effects were most ruinous on the easternmost part of the South Iceland Lowland and in areas south of Hekla. Houses on nine farms collapsed into ruins, and one child died. Surface faulting in the epicentral area was quite extensive. The meizoseismal region is displayed in Figure 6.9a along with the major surface faults. An isoseismal map drawn by Sieberg is reproduced in Figure 6.9b.

[Harboe, 1914; Sieberg, 1932; Tams, 1019, 1927; Björnsson and Einarsson, 1981, Bjarnason et al., 1993]

1913 May 19 1545 66.30-18.80 n 5.63 2 5 *6.3 5.5K

Uppsala reports that the shock was felt in Iceland, but it is not certain that this earthquake was felt on the island. We have negative reports from Grímsey.

[Harboe, 1915; Tams, 1919, 1927]

Earthquakes were felt in South Iceland in April and May. They were related to volcanic eruptions east and north-east of Mt. Hekla.

[Bárdarson, 1930; Ottósson, 1980]

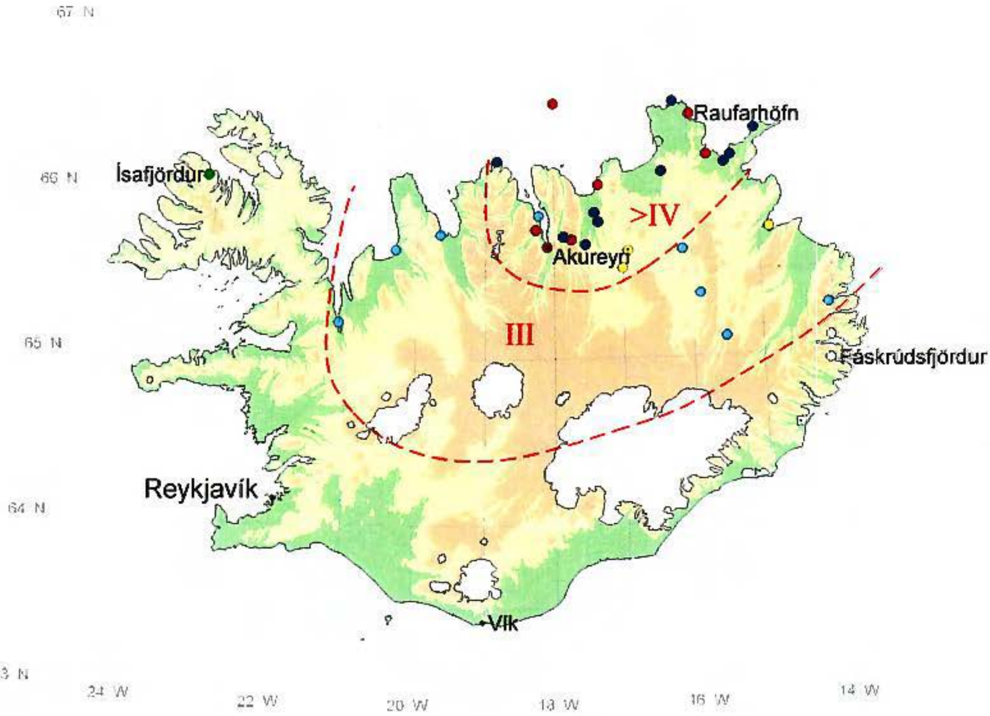

Figure 6.8 – Isoseismals of the earthquake on 22 January 1910, based on data reported by Harboe [1913]. The dots denote places where the earthquake was experienced with Forel-Mercalli intensity according to the colour code; magenta = VIII, red = VII, (dark) blue = VI, yellow = V, green = IV, cyan = III and grey = II.

Figure 6.9a – The destructive earthquake of 6 May 1912 in South Iceland. The following notation is used: — meizoseismal region, where more than 50% of houses collapsed; — major surface faults (based on Sieberg [1920], Björnsson and Einarsson [1981] and Bjarnason et al. [1993]).

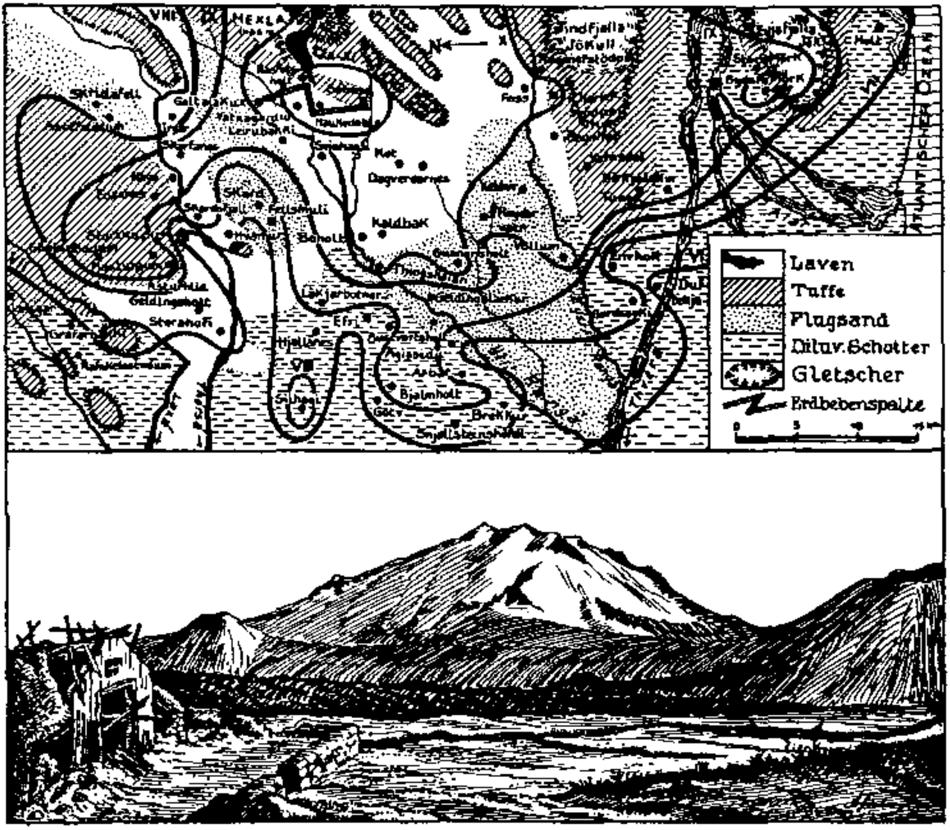

Figure 6.9b – Isoseismals of the destructive earthquake of 6 May 1912, in South Iceland drawn by Sieberg. Mt. Hekla is also shown [Sieberg, 1920].

1913 Jul 26 2051 67.00-18.00 n 5.69 3 9 *6.0 42 5.6K

There is no macroseismic information for this event. Its epicentral location derived from teleseismic readings is roughly 50 km north of the island Grímsey.
[Tams, 1919, 1927]

1914 Jun 19 0006 63.50-24.00r n 5.14 3 7 *5.8 21 5.2K

The earthquake was felt as weak in Reykjavík but of rather long duration [*Ingólfur*, June 21, 1914]. Also, people in the western part of the South Iceland Lowland barely sensed it. The earthquake is mentioned in most of the newspapers in Reykjavík.
[Tams, 1919, 1927; Ottósson, 1980]

1917 Jul 9 0022 62.70-21.40 n 5.79 1 3 18 5.3K

There are no reports from Iceland of this earthquake having been felt. A crude teleseismic location places this event south-west of the island.
[Tams, 1927]

1919 Feb 15 0217 68.20-13.00 n 5.28 3 2 23 5.1K

No macroseismic information. The instrumental readings place the epicentre roughly 250 km NNE of the Icelandic coast.

1920 May 14 1757 64.00-22.00m n 5.16 4 4 20 5.2K

During the period of May 14 to 30, an earthquake sequence shook Southwest Iceland. In Reykjavík the main shock overturned loose objects. No significant damage was reported.
[Thorkelsson, 1923]

1920 Jun 25 1822 64.50-23.40 n 4.87 - 1 10 4.8K

We have not found any reports of this earthquake having been felt. The assessed location, based on teleseismic data, is offshore in the northern part of the Faxaflói Bay.

1921 Aug 23 2017 67.00-18.00 n 6.39 3 13 *6.3 56 6.3K

The earthquake was widely felt in the coastal areas of North Iceland from Blönduós and Saudárkrókur in the West to Raufarhöfn in the East. The earthquake is described as slight with creaking sounds in buildings.
[Tams, 1927; Ottósson, 1980]

1922 Nov 13 0356 66.50-19.50r n 15 4.8K

There are no reports of this earthquake being felt.

The volcano Askja, north of the Vatnajökull Glacier, erupted in March

1921, November 1922, December 1922 and February 1923.
[Gudmundsson, 1986]

```
1923 Oct 20 0024 65.00-16.50r n 4.99 2  2          17   4.7K
1923 Oct 23 1637 65.00-16.50r n                     7
```

There are no reports of these earthquakes' being felt. They were probably related to the above-mentioned volcanic activity in Askja.

```
1924 Sep 04 1601 63.90-22.05m n 5.26 3  9 *5.8     35   5.1K
```

An earthquake was felt widely in Southwest Iceland. It was preceded and followed by many smaller earthquakes. In Krísuvík, the motion was so violent that people outdoors could not stand. However, no significant damage to buildings was reported. A new solfatara formed south of Kleifarvatn. In Reykjavík, the earthquake was described as rather strong; people woke up. In Hafnarfjördur south of Reykjavík, people were frightened and even left their houses. The earthquake was felt as far east as Rangárvellir. The macroseismic epicentre was close to Krísuvík.
[*Morgunbladid*, September 5 and 10, 1924; Ottósson, 1980]

```
1924 Dec 12 0220 63.80-22.80m n 5.24 1  2          17   4.7K
```

An earthquake was felt on Reykjanes Peninsula and in Reykjavík, followed by smaller earthquakes. Its effects are described as slight in Reykjavík. Some damage is reported at the Reykjanes lighthouse. The macroseismic epicentre was probably located south-west of Reykjanes (not far from the lighthouse).
[Ottósson, 1980]

```
1926 Sep 22      63.80-22.80m n                     0   5.1K
```

Many earthquakes were felt on the Reykjanes Peninsula 8 to 30 September 1926. Some broken windows and overturning and sliding of loose objects in buildings were reported.
[Ottósson, 1980]

```
1926 Oct 25 1104 63.80-22.80m n                     1   4.7K
```

Many earthquakes were felt in settlements on the Reykjanes Peninsula 14 to 29 October 1926. The Reykjanes lighthouse was damaged. The lighthouse tower suffered high-level excitation, resulting in a circumferential crack about four meters above ground level. These earthquakes also had significant impact on the Reykjanes geothermal area. People in Grindavík felt the earthquakes as wave motion approaching from the West, but no damage was reported. On the other hand, people at the Reykjanes lighthouse sensed the motion as coming from the East. It therefore seems likely that the macroseismic epicentres are on

the Reykjanes Peninsula somewhat east of the lighthouse.
[*Morgunbladid*, October 26, 1926; Ottósson, 1980]

```
1927 Apr 29 1119 66.30-19.50m n 5.07 -  1          24   4.8K
```

Earthquakes were felt in the coastal areas in North Iceland from Ísafjördur in the West to Akureyri in the East. In Hrútafjördur, an earthquake was felt on the farm Kollsá. The effects of the earthquakes were most notable near Siglufjördur, where house articles indoors moved.
[Thorkelsson, 1940; Ottósson, 1980]

```
1927 Jul 31 2059 66.50-19.00r n 4.80 1  4          19   4.6K
```

No felt reports. Tleseseismic data places the epicentre offshore, near Grímsey.

```
1928 Aug  1 1653 62.70-25.00r n                     6   4.5K
1928 Aug  1 1903 62.70-25.00r n 4.86 -  1           6   4.2K
1928 Aug  1 1946 62.70-25.00r n 4.67 2  2          17   4.6K
1928 Aug  1 2028 62.70-25.00r n 4.69 3  2          15   4.7K
1928 Aug  1 2035 62.70-25.00r n                     1   4.2K
1928 Aug  1 2046 62.70-25.00r n 4.67 2  2          10   4.7K
```

There were no felt reports of these earthquakes with epicentres on the Reykjanes Ridge.

```
1928 Nov  6 0030 63.80-22.80m n                    00   5.1K
```

A series of earthquakes was felt on Reykjanes. The effects of the biggest shock are described as very strong. The light in the Reykjanes lighthouse went out. The geysers of the Reykjanes geothermal area were notably affected.
[*Morgunbladid*, November 8, 1928; Ottósson, 1980]

```
1928 Nov 22 0720 63.80-22.80m n                    00   4.6K
1928 Nov 22 1217 63.80-22.80m n                    00   4.6K
```

A series of earthquakes felt on Reykjanes notably affected the geysers in the Reykjanes geothermal area. The strongest earthquakes, described as moderate, were felt in Reykjavík.
[*Morgunbladid*, November 23, 1928; Ottósson, 1980]

```
1928 Dec  2 2252 64.00-21.30m n                     2   4.6K
```

An earthquake was felt over a large area in Southwest Iceland. The effects are described as slight in Reykjavík but moderate in Kjós, Thingvellir, Grímsnes and Ölfus. The effects were greatest in Hveradalir. The macroseismic epicentre was on Hellisheidi.
[*Morgunbladid*, November 23, 1928; Ottósson, 1980]

1928 Dec 6 1522 64.00-21.30m n 1 4.6K

An earthquake was felt in Southwest Iceland, followed by many smaller earthquakes. The effects in Reykjavík are described as slight. These earthquakes are probably aftershocks of the earthquake from 2 December.

[Ottósson, 1980]

1929 Jan 6 0002 63.70-23.00m n 5.41 0 2 26 5.4K

An earthquake, widely felt on the Reykjanes Peninsula was perceptible as far east as Hveradalir and as far west and north, respectively, as Kolbeinsstadahreppur and Nordtunga. It was also felt in Reykjavík (MMI IV) but not mentioned in local newspapers. A series of earthquakes preceded and followed it.

[Ottósson, 1980]

1929 May 24 0650 63.80-22.80m n 00 4.6K

An earthquake was felt on the Reykjanes Peninsula. The effects are described as strong. It was followed by an aftershock.

[Ottósson, 1980]

1929 Jul 23 1843 63.90-21.70m n 6.31 3 21 97 6.3K

An earthquake was felt throughout Southwest Iceland, South Iceland as far as Skeidarársandur, West Iceland as far as Ísafjördur and North Iceland as far as Siglufjördur. The effects in Reykjavík are described as strong or even very strong. The walls of the parliament building (Althing) and some other buildings made of natural stone (dolerite) sustained some damage. Some cracks developed in walls and slabs of concrete buildings. A few chimneys fell down. Windows broke in some places, and a lot of glassware was destroyed. People ran outdoors. The pier in the harbour was damaged. A wave was observed on Lake Thingvallavatn moving north-east with great speed. The macroseismic epicentre of this earthquake was in Brennisteinsfjöll Mountains. G. Bárdarson, a geologist on a field excursion when the earthquake struck gave a very good description of the impact of this earthquake in the epicentral area [Visir, July 25, 1929]. He noted two foreshocks and three aftershocks.

[*Vísir*, July 25 and 30, 1929; *Morgunbladid*, July 24, 1929; Ottósson, 1980]

1929 Jul 23 2004 63.90-21.70m n 5.35 2 3 18 5.1K

This was the third aftershock of the earthquake in Brennisteinsfjöll mentioned above.

[*Vísir*, July 25, 1929]

1930 Apr 8 1135 63.80-22.80m n 1 4.2K

Many earthquakes were felt on the Reykjanes Peninsula. The lighthouse tower vibrated, and objects indoors toppled along with house articles. The earthquake was also felt in Sandgerdi.
[Tryggvason, 1978]

1930 Aug 25 1535 63.90-22.20m n 4.73 - 1 2 4.5K

A series of earthquakes was felt in Reykjavík, Keflavík and Grindavík. The macroseismic epicentres were near Mt. Keilir.
[Tryggvason, 1978]

1931 Jan 31 0704 64.00-21.50m n 1 3.7K

An earthquake was felt in Hveradalir (MMI V).
[Tryggvason, 1978]

1931 Aug 23 1005 64.00-21.50m n 2 3.7K
1931 Aug 23 1553 64.00-21.50m n 2 5.1K

Earthquakes were felt over a large area in South Iceland. The last one was the biggest. It was felt as far east as Skaptártunga and Mýrdalur. It was also felt in Hvolhreppur, Land, Hrunamannahreppur and Laugarvatn. To the North, it was felt in Akranes. In Stokkseyri and Eyrarbakki as well as the Reykjahverfi in Ölfus, where changes in the geothermal area were observed, house articles were damaged. The effects, however, were most notable in Hveradalir (MMI V). There was rockfall in the mountains Ingólfsfjall and Hengill. The macroseismic epicentre was on Hellisheidi.
[Tryggvason, 1978]

1932 Mar 18 0722 63.80-22.80m n 1 3.7K
1932 Mar 18 0850 63.80-22.80m n 00 3.7K
1932 Mar 18 0929 63.80-22.80m n 1 3.7K
1932 Mar 18 2045 63.80-22.80m n 00 3.7K
1932 Mar 18 2157 63.80-22.80m n 1 3.7K

An earthquake swarm was felt on the Reykjanes Peninsula. The earthquakes induced some cracks in the Reykjanes lighthouse.
[Tryggvason, 1978]

1932 Apr 17 1334 63.80-22.80m n 1 4.2K

A series of earthquakes was felt on Reykjanes. The effects were most notable in Grindavík, but were also felt in Reykjavík (MMI III).
[Tryggvason, 1978]

```
1932 Nov  2 0842 63.80-22.90m n                     1   4.6K
1932 Nov  2 1233 63.80-22.90m n                     1   5.1K
1932 Nov  2 1431 63.80-22.90m n                     1   4.6K
```

An earthquake swarm was felt in settlements on the Reykjanes Peninsula. The equipment in the Reykjanes lighthouse sustained significant damage (MMI VII). The swarm was also felt in Reykjavík (MMI IV)

[Thorkelsson, 1935; Tryggvason, 1978]

```
1933 Jun 10 1207 63.90-22.20m n 5.69 2 13          64   5.6K
1933 Jun 10 1415 63.90-22.20m n                     0   4.2K
1933 Jun 10 1513 63.90-22.20m n                     3   4.2K
1933 Jun 10 1630 63.90-22.20m n 4.81 -  1          15   4.6K
1933 Jun 10 2038 63.90-22.20m n                     3   4.2K
```

A series of earthquakes was felt in Southwest Iceland. The biggest earthquake was felt as far north as Ísafjördur and as far towards east as Landeyjar, Hvolhreppur and Land. The greatest impact was on a farm near Krísuvík. The maximum felt effects in Reykjavík were MMI V.

[Tryggvason, 1978]

```
1933 Oct  5 0550 68.50-19.50A n 5.05 0  2          12 i 4.9K
1933 Oct  5 0622 68.50-19.50A n 5.13 1  3          15 i 5.0K
```

No macroseismic information. The location is about 250 km north of Grímsey.

```
1934 Jun 02 1342 65.95-18.50m n 6.17 2 26 *6.2   118    6.1K
```

A destructive earthquake occurred in North Iceland, known as the Dalvík Earthquake, named after a small fishing village, Dalvík, in Eyjafjördur. The effects of the earthquake were greatest in Dalvík, Svarfadardalur and Hrísey. This is indicated in Figure 6.10, where MCS intensity contours are also shown. The following description is based to a large extent on unpublished material compiled by Thráinsson [1994].

In Dalvík and the surrounding countryside, 12 dwellings were destroyed, and 43 sustained moderate to heavy damage. No building collapsed. Out of 17 traditional houses, 6 were destroyed, and only 2 suffered minor damage. Out of 32 (unreinforced) concrete houses, 6 were destroyed, 16 were severely damaged, and only 5 had minor damage. There were only two buildings of reinforced concrete. They resisted the earthquake without any visible damage. Out of 27 timber houses, only 4 were significantly damaged, and 13 were not damaged at all. In addition, there were significant damages to the freezing plant, butchery and meeting house. A majority of chimneys broke, in most cases above roof level.

In Hrísey, an island in Eyjafjördur, 48 buildings were damaged; thereof five houses of concrete were destroyed. The church suffered severe damages.

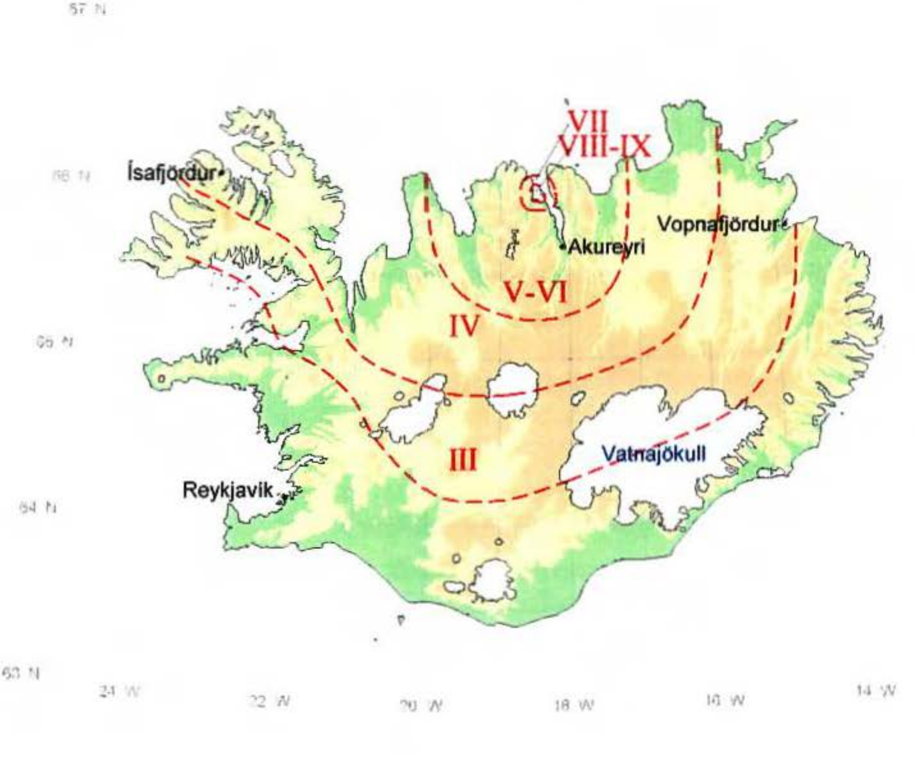

Figure 6.10a – Isoseismals of the Dalvík Earthquake on 2 June 1934 (based on the work of Thórarinsson [1937]).

(a)

(b)

Figure 6.10b – The Dalvík Earthquake. (a) Earthquake induced damages of an unreinforced concrete building. (b) Damage of a road near Dalvík [Bjarnason,1978].

In Svarfadardalur, 14 farmhouses collapsed. There were also some damages to the road system, including two small bridges.

There are no traces of surface faulting on the land. The reason is probably that the epicentre is located in the sea between Dalvík and Hrisey. The earthquake was followed by many aftershocks.

[Thórarinsson, 1937; Tryggvason, 1978; Björnsson and Einarsson, 1981; Thráinsson, 1994]

1934	**Jun**	**2**	**1455**	**65.95–18.50m**	**n**				**1**	**4.6K**
1934	**Jun**	**2**	**1836**	**65.95–18.50m**	**n**				**1**	**4.6K**
1934	**Jun**	**3**	**2034**	**65.95–18.50m**	**n**	**4.89**	**4**	**2**	**12**	**4.4K**
1934	**Jun**	**4**	**1455**	**65.95–18.50m**	**n**				**00**	**4.6K**
1934	**Jun**	**4**	**2110**	**65.95–18.50m**	**n**				**00**	**4.6K**
1934	**Jun**	**5**	**1200**	**65.95–18.50m**	**n**				**00**	**5.1K**
1934	**Jun**	**9**	**1410**	**65.95–18.50m**	**n**				**00**	**4.6K**
1934	**Jun**	**16**	**0840**	**65.95–18.50m**	**n**				**00**	**4.6K**
1934	**Jun**	**20**	**1740**	**65.95–18.50m**	**n**				**00**	**5.1K**
1934	**Jul**	**5**	**0745**	**65.95–18.50m**	**n**				**00**	**5.6K**

The Dalvík Earthquake aftershocks.

1935 Oct 14 1030 64.00–21.50m n 16 4.6K

An earthquake was felt over a big area of South and West Iceland. It was felt as far east as Vík in Mýrdalur and was also felt in Fljótshlíð, Hvolhreppur, Land, Hrunamannahreppur and Thingvellir. To the North, it was felt in Ísafjörður and to the West in Reykjanes. There was some 'structural' damage to a cowshed on one farm in Hjallahverfi in Ölfus. The effects were, however, most notable in Hveradalir (MMI VI+). The damage to house articles was significant. There was some structural damage, and one chimney fell down. There was rockfall on the nearby mountain. Assessed intensities are displayed in Figure 6.11. The macroseismic epicentre was on Hellisheidi. Aftershocks accompanied this earthquake.

[Tryggvason, 1978]

1935 Oct 14 1030 64.00–21.50m n 16 4.6K

An earthquake was felt over large part of Southwest Iceland as far east as Vík and as far north as Borgarfjördur. The earthquake was most intense in Hveradalir (MMI V). There was an aftershock from the above-mentioned earthquake.

[Tryggvason, 1978]

1936 Jul 14 1837 64.40–20.70m n 1 4.5K

An earthquake was felt at Laugarvatn and in Reykjavík.

[Tryggvason, 1978]

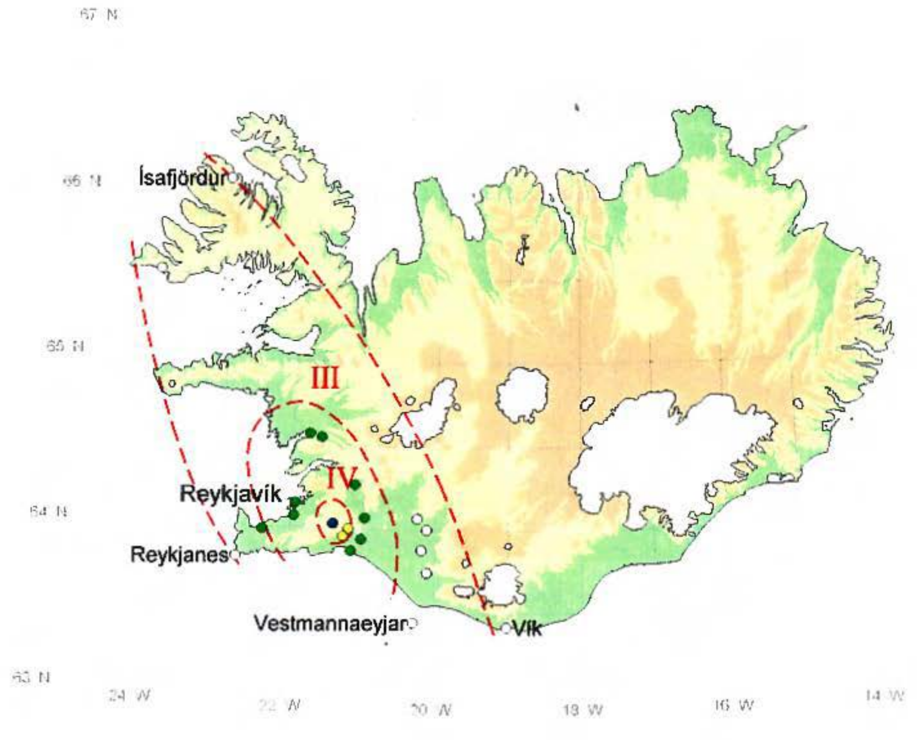

Figure 6.11 – Assessed intensities of the earthquake on 9 October 1935 (based on macroseismic information reported by Tryggvason [1978]). The dots are places where the earthquake was experienced with intensity according to the colour code: blue = VI, yellow = V, green = IV and white = III.

1936 Sep 21 1810 63.80-22.80m n 15 4.6K

A series of earthquakes was felt on the Reykjanes Peninsula. Some damage was reported (MMI VI?). It was felt as far east as Eyrarbakki and as far north as Borgarfjördur as well as in Reykjavík (MMI III).
[Tryggvason, 1978]

1936 Oct 22 2349 66.80-17.40m n 5.32 3 19 45 5.3K
1936 Oct 23 0000 66.80-17.40m n 5.40 3 15 36 5.4K
1936 Oct 23 0250 66.80-17.40m n 4 4.5K

Earthquakes were felt in North Iceland from Blönduós in the West to Bakkafjördur and Vopnafjördur in the East. The effects were most notable in Húsavík (MMI V), where house articles moved and toppled.
[Tryggvason, 1978]

1938 Feb 10 0703 64.60-23.00m n 5.20 1 3 70 5.2K
1938 Feb 10 0829 64.60-23.00m n 2 4.8K

Earthquakes were felt in the north-eastern part of Faxaflói as well as in Reykjavík.
[Tryggvason, 1978]

1938 Jul 8 2251 66.50-17.00m n 1 4.2K
1938 Jul 9 0921 66.50-17.00m n 1 4.2K

Earthquakes were felt in Raufarhöfn, Húsavík and Grímsey.
[Tryggvason, 1978]

1940 Jan 12 0940 66.00-17.50m n 00 4.6K

Earthquakes were felt in the eastern part of North Iceland, from eastern Skagafjördur in the West to Raufarhöfn in the East. The earthquake's impact was greatest in Húsavík (MMI IV+), where house articles moved and fell from shelves. The wave motion appeared to be from the Southeast.
[*Morgunbladid*, January 13, 1940; Tryggvason, 1978b]

1940 Jun 4 0150 63.80-22.80m n 1 5.1K

Many earthquakes were felt on the Reykjanes Peninsula.
[Tryggvason, 1978b]

1942 Apr 25 2002 66.30-19.50m n 00 4.5K

An earthquake was felt in North Iceland from Blönduós in the West to Húsavík in the East. The earthquake was strongest at Siglufjördur (MMI V?). There was some panic but no damage.
[Tryggvason, 1978b]

1942 Jun 17 2214 64.00-20.70m n 00 4.2K

An earthquake was felt in Stórólfshvoll and a few other farms on the South Iceland Lowland as well as in Reykjavík.
[Tryggvason, 1978b]

1942 Nov 19 1755 63.50-23.00m n 00 4.8K

A weak earthquake was felt at Reykjanes (MMI III).
[Tryggvason, 1978b]

1944 Feb 4 1833 66.10-17.50m n 2 4.6K

1944 Feb 6 1706 66.10-17.50m n 1 4.6K

1944 Feb 10 0320 66.10-17.50m n 00 4.1K

Earthquakes were felt in Húsavík. Some damage occurred in the first earthquake (MMI VI). They were also felt in Akureyri.
[Tryggvason, 1978b]

1944 Feb 19 1135 63.40-23.80r n 5.41 3 6 29 5.4K

1944 Feb 20 1932 63.40-23.80r n 5.07 1 3 16 5.5K

1944 Feb 21 1526 63.40-23.80r n 5.18 0 4 15 5.2K

1944 Feb 21 1734 63.40-23.80r n 4.97 0 2 14 5.0K

An earthquake swarm was felt at Reykjanes.

1944 Aug 22 2140 66.10-17.50m n 1 4.6K

An earthquake was felt in Húsavík. No other location mentioned this earthquake.
[Tryggvason, 1978b]

1947 Mar 29 0750 64.00-19.70m n 4.76 0 2 12 5.0K

An earthquake, related to the volcanic eruption of Mt. Hekla, was felt over most of South Iceland.

1947 May 19 0657 64.00-21.20m n 1 3.7K

1947 May 19 1143 64.00-21.20m n 2 4.2K

Earthquakes were felt in Hveragerdi, Selfoss and Eyrarbakki as well as the neighbouring areas. The strongest earthquake was felt in Hveragerdi (MMI VII). It caused significant damage to buildings and geothermal heating systems. In Gufudalur, a new concrete building was severely damaged. Windows in greenhouses were broken, and house articles fell on the floor and were damaged. However, no injuries were reported.
[Tryggvason, 1978b]

```
1947 May 25 0401 63.90-22.10m n                   2    4.2K
```

An earthquake was felt in Reykjavík (MMI III), Krísuvík, Land (?) and Helgafellssveit on the Snæfellsnes Peninsula.
[Tryggvason, 1978b]

```
1947 Jun 28 1724 66.30-19.00m n                   4    4.2K
1947 Jun 28 2222 66.30-19.00m n                  23    4.5K
```

Earthquakes were felt in Siglufjördur.
[Tryggvason, 1978b]

```
1947 Aug 12 1559 64.00-19.70m n                  13    4.1K
```

An earthquake was felt in Land, Rangárvellir and Fljótshlíd as well as Hrunamannahreppur.
[Tryggvason, 1978b]

```
1948 Jun 24 0206 63.90-22.10m n                  15    4.9K
1948 Jun 24 0212 63.90-22.10m n 4.9    1               5.1K
```

Earthquakes were felt in Southwest Iceland. The area of perceptibility was from Gnúpverjahreppur in the East to Helgafellssveit in Snæfellsnes. The effects were strongest in Krísuvík (MMI VI), where one chimney fell down.
[Tryggvason, 1978b]

```
1948 Jul  3 1545 64.00-20.50m n 4.52 1  2        14    4.7K
```

An earthquake was felt in South Iceland. The area of perceptibility was from Fljótshlíd to Reykjavík. The effects were strongest in Holt and Land (MMI VI+). Farm buildings were damaged, and tombstones fell. Newly cast concrete walls on a building under construction in Skeid collapsed.
[*Morgunbladid*, July 23, 1948; Tryggvason, 1978b]

```
1948 Aug 30 0139 66.50-18.00m n 4.75 1  3        23    4.6K
```

There were no reports of an earthquake being felt. The above-reported location is near to Grímsey.
[Tryggvason, 1978b]

```
1950 Jul 19 0536 63.80-20.80m n 4.9    1         15    4.9K
```

An earthquake was felt over most of the South Iceland Lowland. The effects were strongest in Eyrarbakki (MMI IV) and on farms in south-western Flói. The area of perceptibility was from Mýrdalur to Ölfus.
[Tryggvason, 1979]

1952 Mar 12 1213 63.90-22.10m n 4.71 2 3 35 4.7K

An earthquake was felt over a considerable part of Southwest Iceland. The effects were strongest in Krísuvík (MMI VI). There was no damage. The area of perceptibility was from Thorlákshöfn and Hveragerdi to Helgafellssveit on the Snæfellsnes Peninsula.

[Tryggvason, 1979]

1952 May 16 1432 63.90-22.00m n 4.84 2 2 13 4.8K

An earthquake was felt over a considerable area in Southwest Iceland. The area of perceptibility appears to have been smaller than the area of the above-mentioned earthquake. The effects were strongest in Krísuvík (MMI VI+), where house articles moved, dishes broke, cracks were observed in concrete walls, and piping systems in greenhouses were damaged. A number of aftershocks followed the earthquake.

[Tryggvason, 1979]

1955 Jan 15 1646 63.90-22.25m n 1 4.6K

In the period of 14-16 January 1955, an earthquake swarm passed over the Reykjanes Peninsula. The effects were strongest in Ísólfsskáli (MMI V+) about 4 km east of Grindavík. There was no damage to buildings, but house articles moved and even toppled. The area of perceptibility stretched from Flói to Borgarfjördur.

[Tryggvason, 1979]

1955 Feb 27 0737 66.20-16.30m n 4.6K
1955 Feb 27 0747 66.12-16.25 n 4.4 s 4.6K
1955 Feb 27 0828 66.20-16.30m n 4.6K

A sequence of earthquakes, or an earthquake swarm, was felt in Northeast Iceland. The effects were strongest on farms in Öxarfjördur (MMI VI). Cracks were observed in (unreinforced) concrete walls. House articles moved and toppled. The area of perceptibility was from Vopnafjördur to Ólafsfjördur. However, they were not felt near Mývatn.

[Tryggvason, 1979]

1955 Feb 28 0400 66.20-16.30m n 4.6K

This is an earthquake in the above-mentioned sequence.

1955 Mar 13 0213 64.20-20.70m n 4.6K

An earthquake was felt in South Iceland. The strongest effects reported were in Laugardalur (MMI IV). People woke up. There was some panic but no damage to buildings. The earthquake was perceptible from Rangárvellir to Mosfells-

sveit. At Reykalundur in Mosfellssveit the effects were assessed to MMI IV.
[Tryggvason, 1979]

```
1955 Apr  1 1726 64.10-21.20m n                              4.6K
1955 Apr  1 1841 64.10-21.20m n 4.91 1  3 *5.1     40    5.2K
```

An earthquake swarm in the Hengill area was felt throughout Southwest Iceland. The biggest earthquake on the 1 April had the highest observed intensities in Hveragerdi (MMI VII) and Hjalli in Ölfus. Damage occurred in Hveragerdi. Figure 6.12 shows an intensity map of the earthquake 18h 41m.
[Tryggvason, 1956, 1979]

```
1955 May 19 0311 66.50-17.50m n 4.36    1 *5.2           5.0K
```

An earthquake was felt in Northeast Iceland. It was perceptible from Vopnafjördur to Fljót in Skagafjördur.
[Tryggvason, 1956, 1979]

```
1956 Jun  1 1046 63.96-21.88  n 4.05    1              s 4.7s
```

An earthquake swarm was felt in the settlements on the Reykjanes Peninsula. The strongest effects were reported in Krísuvík.
[Tryggvason, 1979]

```
1956 Jun 10 1405 64.40-17.70  n 4.24 1  2                4.7r
```

There were no reports of an earthquake being felt. The above-reported location is in the western part of the Vatnajökull Glacier.

```
1956 Oct 29 1348 66.46-19.02  n                        s 4.5s
1956 Oct 29 1621 66.46-17.73  n 4.63    1              s 4.6s
1956 Oct 29 1632 66.59-17.09  n                        s 4.3s
1956 Oct 30 0011 66.48-17.73  n 4.82 2  4              s 4.9s
```

An earthquake sequence was felt widely in North Iceland, especially in the eastern part. The earthquakes were perceptible from Vopnafjördur to Skagafjördur. The strongest effects were reported in Grímsey (MMI IV).
[Tryggvason, 1979]

```
1957 Dec  9 0802 64.72-18.05  n                        s 4.5s
```

No macroseismic data were found. The above-reported instrumental epicentre is in the area of the Tungnafellsjökull Glacier.

```
1958 Feb 16 2302 67.61-18.84  n 4.60 1  3              s 4.5s
```

There are no felt reports. The above location is 120 km north of Grímsey.

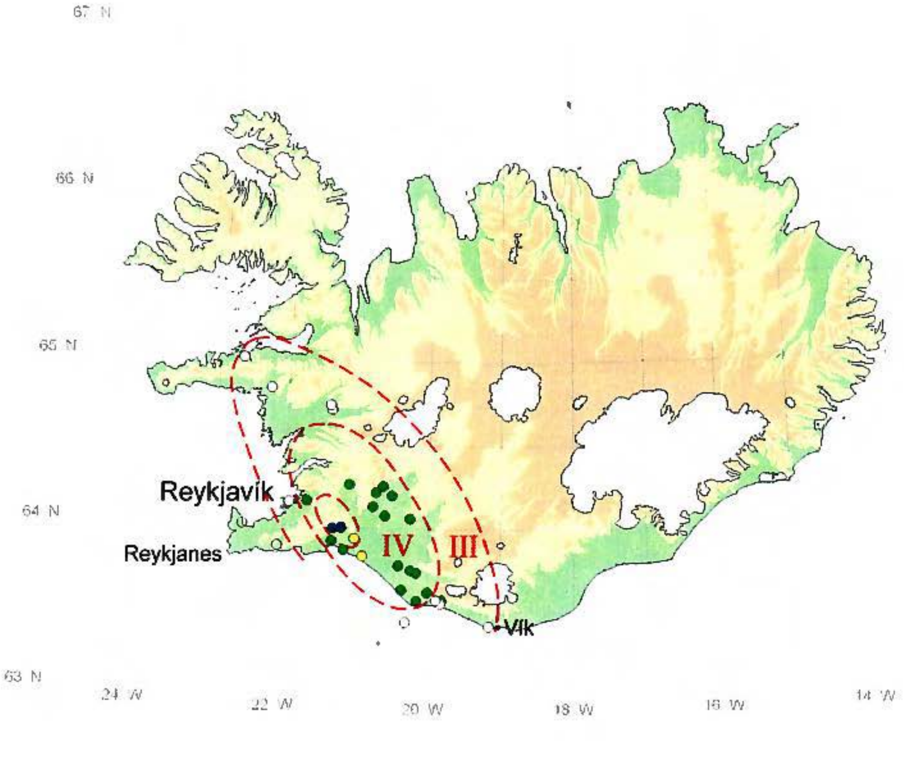

Figure 6.12 – Isoseismals of the earthquake on 1 April 1955 (based on macroseismic information reported by Tryggvason [1979]). The dots are places where the earthquake was experienced with intensity according to the colour code: blue = VI, yellow = V, green = IV and white = III.

1958 May 19 1725 63.79-19.22 n s 4.0s

No macroseismic information is available. The location is in the area of the Mýrdalsjökull Glacier.

1958 Sep 27 1041 66.07-18.08 n 3.94 1 s 4.6s

An earthquake was felt in the settlements around Skjálfandaflói and Eyjafjördur. The area of perceptibility was from Tjörnes in the East to Fljót in Skagafjördur in the West. The earthquake was not felt in Öxarfjördur. The effects reported in Húsavík were strong (MMI IV+).

[Tryggvason, 1979]

1958 Dec 6 0943 66.42-18.75 n s 3.9s
1958 Dec 6 1112 66.42-18.27 n s 4.7s
1958 Dec 6 1533 66.40-18.12 n s 4.6s

An earthquake swarm was felt in the middle part of North Iceland. The earthquakes were perceptible from Tjörnes to Hofsós in Skagafjördur.

[Tryggvason, 1979]

1959 Feb 2 1554 64.56-17.24 n s 4.0s

No macroseismic information is available. The above epicentral location is in the western part of the Vatnajökull Glacier.

1959 Jun 28 0423 63.97-19.32 n 4.38 2 5 s 4.7s

People (tourists?) staying in Landmannalaugar felt an earthquake very strongly. It was barely noticeable in the countryside east of Landmannalaugar and not at all to the West.

[Tryggvason, 1979]

1959 Dec 8 0808 66.95-18.78 n 4.54 1 s 4.8s

An earthquake was felt in Grímsey, Tjörnes and Húsavík. The reported effects were strong in Grímsey.

1960 Feb 21 0423 64.59-17.09 n s 4.3s

No macroseismic data are available. The location is in the western part of the Vatnajökull Glacier.

1961 May 14 1508 67.70-18.40 n 4.31 1 5 u
1961 May 14 1538 67.65-18.56 n 4.66 1 6 u 4.8u

No macroseismic data are available. The epicentres of these earthquakes are located roughly 130 km north of the island Grímsey.

```
1961 Oct 26 1155 65.10-16.70  n                      b
```

There is no report of felt effects from this earthquake, which is located in the area of the volcano Askja.

```
1962 Jun 12 0126 64.80-16.80  n 3.7     1            b 4.2s
1962 Jun 12 0946 64.90-17.10  n 4.06 0  3            b 4.4s
```

These earthquakes are located near the northern edge of the Vatnajökull Glacier, west of Kverkfjöll. No macroseismic data are available.

```
1962 Dec 15 0347 67.40-13.90  n                      b
```

There is no report of felt effects from this earthquake located about 140 km NE of Raufarhöfn.

```
1963 Mar 28 0016 66.37-19.69  n 6.85 1 14 *6.7    63 i 6.8u
```

The so-called Skagafjördur Earthquake had its epicentre offshore from Skagafjördur. *The earthquake was felt over most of the island. The effects were* most noticeable in Skagafjördur, Eyjafjördur and Húnaflói, where some communities suffered blackout, which increased the widespread panic. The church bells in Siglufjördur started ringing. The effects at the hospital in Saudárkrókur were notable. Patients were frightened, and some had nervous breakdowns. Sterilisation equipment moved but did not topple. Some damage on the hospital building was visible, minor cracks in concrete walls and movement in expansion joints. Cracks in concrete and masonry walls were also reported from other places as well as broken windows in few cases. No significant damage to dwellings was, however, reported. Some damage to house articles was mentioned in a number of occasions. Three people were seriously injured, two of them 'broke' their legs when they panicked and fell downstairs in an attempt to get out and one person was cut by a glass from a broken window.

Some people observed a bright light, like white and red lightening, in the 'southern' sky just before the 'main' shock. Reports on this phenomenon are from Skagafjördur and from pilots of military aeroplanes (at cruising altitude) near Hornafjördur.

The earthquake was accompanied by foreshocks and many aftershocks (see in the following). Figure 6.13 shows the intensity map for this earthquake.

[*Morgunbladid*, March 28, 29, 30, 1963; *Tíminn*, March 29, 1963; *Thjódviljinn*, March 28, 30, 1963; *Vísir*, March 28, 29, 1963; *Althýdubladid*, March 29, 30, 1963; Halldórsson, 1964]

```
1963 Mar 28 0026 66.30-20.20  n 4.0     1  4.6       u 5.0u
1963 Mar 28 0059 66.40-19.60  n            4.5       u 4.7u
1963 Mar 28 0128 66.60-20.00  n                      u 4.6u
```

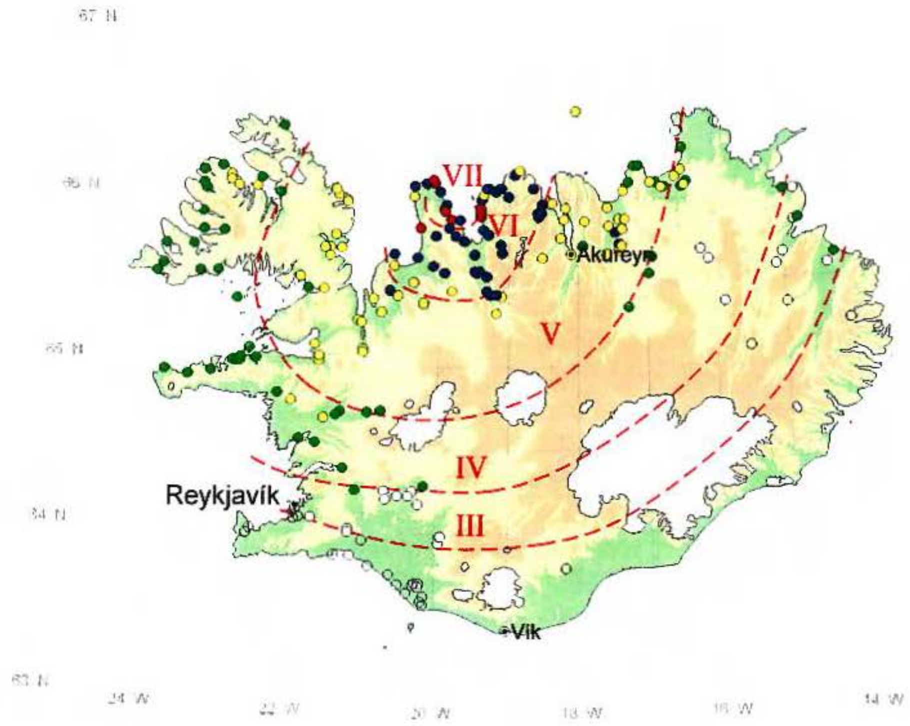

Figure 6.13 – Isoseismals of the Skagafjördur Earthquake on 28 March 1963 (based on data reported by Halldórsson [1984]). The dots are places where the earthquake was experienced with intensity according to the colour code: red = VII, blue = VI, yellow = V, green = IV, white = III and no colour = II.

```
1963 Apr 27 0342 66.70-19.20  n 4.34 1  4  4.6       u 4.6u
```

Some of these offshore earthquakes are undoubtedly aftershocks of the Skagafjördur Earthquake.
[*Morgunbladid*, April 28, 1963]

```
1963 Jun 28 1515 67.20-18.70  n            4.3       u
1963 Jun 28 1601 67.50-18.70  n 3.97 1  2  4.4       u 4.2u
```

There are no felt reports on these earthquakes located approximately 80 to 120 km north of Grímsey.

```
1963 Sep  3 0913 62.80-25.20  n 4.28 1  6  4.9       u 4.3u
```

Felt effects are not reported from this earthquake located on the Reykjanes Ridge.

```
1963 Oct 15 0959 67.20-18.40  n 5.71 2 12  5.2       u 5.6u
```

Three mild earthquakes felt in Grímsey. There are also reports of felt effects from Siglufjördur. The above earthquake is located 80 km north of Grímsey.
[*Morgunbladid*, October 16, 1963; *Vísir*, October 15, 1963]

```
1964 Feb 26 2259 64.70-17.30  n 3.8     1  4.5     8 i
```

This earthquake is located near Bárdarbunga in the Vatnajökull Glacier. No macroseismic information is available.

```
1964 Jul 11 1744 66.24-19.86 17 4.54 1 15  4.9    95 e
```

There were no reports of an earthquake being felt. The instrumental data places the epicentre offshore, outside Skagafjördur.

```
1964 Aug 20 0356 63.89-20.48 21 4.87 1 15  4.0    84 e
```

An earthquake in the South Iceland Lowland was felt from Núpstadur in the East to Helgafellssveit on the Snæfellsnes Peninsula in the West. The effects were most significant at Hella in Rangarvellir, where people woke up, house articles fell and tombstones toppled. There was minor damage to buildings, like cracks in (unreinforced) concrete walls. The central heating system in two houses failed. The fill-material in the abutments on the east side of the bridge over Ytri-Rangá at Hella subsided by almost 15 cm.

```
1965 May 29 2256 63.15-24.60  n 4.16 0  2  4.4    21 i
1965 Jul 11 0952 62.36-25.65 15            4.6    31 e
```

No macroseismic information is available. The epicentres were offshore, on the Reykjanes Ridge.

1966	Mar	26	1229	63.09-24.38	32	4.32	0	2	4.6	28	e

This earthquake is located on the Reykjanes Ridge. No reports on felt effects have been found.

1966	Apr	08	2317	67.80-19.20	n	4.21	0	2	4.3	12	i

No felt effects from this earthquake located 150 km north of Grímsey.

1966	Dec	22	1539	64.63-17.20	n				4.8	7	i

An earthquake with epicentre in the Bárdarbunda area. There are no reports on felt effects.

1967	Mar	11	1223	63.70-19.00	n				4.4	16	i
1967	Apr	1	1242	63.62-19.05	17	4.5		1	4.8	56	e
1967	May	16	1611	63.59-18.90	4	4.09	1	6	4.3	24	i
1967	Jun	7	0258	63.56-19.25	26	4.00	1	2	4.5	36	e

Earthquakes located in the Mýrdalsjökull Glacier. No macroseismic information was found.

1967	Jul	26	2159	66.39-17.20	n				4.2	14	i

The location is offshore, north of Tjörnes. No felt effects were reported.

1967	Jul	27	0517	63.97-20.87	1	4.61	1	7	5.0	96	e

An earthquake was felt over a large part of the South Iceland Lowland. The effects were described as strong in Flói, house articles fell from shelves or toppled. There was minor damage to buildings, such as cracks in plaster and (unreinforced) concrete walls; some chimneys broke. There were both for- and aftershocks.

[*Morgunbladid*, July 28, 1967]

1967	Jul	28	1535	64.00-20.94	1	4.38	0	6	4.7	80	e
1967	Jul	29	0221	63.90-20.80	n	4.23	1	6	4.7	46	i

These earthquakes are aftershocks of the above-described earthquake.

1967	Sep	30	0234	63.80-22.70	13	4.56	1	2	4.4	30	i
1967	Sep	30	0419	63.80-22.70	n	4.56	1	2	4.4	23	r
1967	Sep	30	0420	63.90-22.28	n				4.5	15	r
1967	Sep	30	0430	63.97-22.40	n	4.42	0	2	4.3	23	i

An earthquake swarm on the Reykjanes Peninsula was felt in the settlements there. It was perceptible from Stokkseyri to Reykjavík. The effects on Reykjanes were most significant. People left their dwellings, and house articles moved. There was structural damage to the lighthouse; the bearing wall cracked all the way around. The earthquakes had significant effects on the Reykjanes geothermal area.

[*Morgunbladid*, September 30, 1967]

1967 Oct 04 2147 63.66-19.15 10 4.53 0 3 4.5 28 e

A mild earthquake was felt in Mýrdalur.

[*Morgunbladid*, October 4, 1967]

1967 Nov 06 0411 67.90-18.70 n 4.2 15 i
1967 Nov 06 0549 67.90-18.90 n 4.03 4 2 4.4 24 i

Earthquakes located more than 150 km north of the island Grímsey. No macroseismic information is available.

1968 Jul 30 0224 66.42-17.50 1 4.25 0 2 4.3 27 i

An earthquake located offshore, approximately 30 km north of Tjörnes. Felt effects were not reported.

1968 Nov 08 1611 64.39-18.10 n 4.71 3 4 4.4 37 i

No macroseismic information is available. This earthquake is located near Mt. Kerlingar at the western edge of the Vatnajökull Glacier.

1968 Nov 09 1920 64.03-21.12 5 4.4 46 e

An rather strong earthquake was felt in the South Iceland Lowland. The earthquake was perceptible as far east as Vík and as far west as Reykjavík. The effects were strongest in Selfoss, where house articles fell from shelves. We have not found evidence of damage in other places, neither in Hveragerdi nor in Eyrarbakki.

[*Morgunbladid*, November 12, 1968]

1968 Dec 5 0944 63.90-21.81 5 5.97 2 30 5.5 239 e

An earthquake with its epicentre on Reykjanes Peninsula was felt from Kirkjubæjarklaustur in the East to Búdardalur in West Iceland. The earthquake did not cause any significant damage in Reykjavík or Hafnarfjördur. A blackout occurred in Hafnarfjördur, lasting a few minutes after the earthquake.

[*Morgunbladid*, December 6, 1968]

1969 Apr 1 0410 66.44-17.67 9 4.25 1 6 4.5 48 e
1969 Apr 3 1652 66.39-17.80 n 4.4 18 i

Earthquakes located offshore SE of the island Grímsey. No macroseismic information is available.

1969 May 5 2147 66.90-18.28 1 5.09 2 11 5.2 144 e

all the way around. The earthquakes had significant effects on the Reykjanes geothermal area.

[*Morgunbladid*, September 30, 1967]

1967 Oct 04 2147 63.66–19.15 10 4.53 0 3 4.5 28 e

A mild earthquake was felt in Mýrdalur.

[*Morgunbladid*, October 4, 1967]

1967 Nov 06 0411 67.90–18.70 n 4.2 15 i
1967 Nov 06 0549 67.90–18.90 n 4.03 4 2 4.4 24 i

Earthquakes located more than 150 km north of the island Grímsey. No macroseismic information is available.

1968 Jul 30 0224 66.42–17.50 1 4.25 0 2 4.3 27 i

An earthquake located offshore, approximately 30 km north of Tjörnes. Felt effects were not reported.

1968 Nov 08 1611 64.39–18.10 n 4.71 3 4 4.4 37 i

No macroseismic information is available. This earthquake is located near Mt. Kerlingar at the western edge of the Vatnajökull Glacier.

1968 Nov 09 1920 64.03–21.12 5 4.4 46 e

An rather strong earthquake was felt in the South Iceland Lowland. The earthquake was perceptible as far east as Vík and as far west as Reykjavík. The effects were strongest in Selfoss, where house articles fell from shelves. We have not found evidence of damage in other places, neither in Hveragerdi nor in Eyrarbakki.

[*Morgunbladid*, November 12, 1968]

1968 Dec 5 0944 63.90–21.81 5 5.97 2 30 5.5 239 e

An earthquake with its epicentre on Reykjanes Peninsula was felt from Kirkjubæjarklaustur in the East to Búdardalur in West Iceland. The earthquake did not cause any significant damage in Reykjavík or Hafnarfjördur. A blackout occurred in Hafnarfjördur, lasting a few minutes after the earthquake.

[*Morgunbladid*, December 6, 1968]

1969 Apr 1 0410 66.44–17.67 9 4.25 1 6 4.5 48 e
1969 Apr 3 1652 66.39–17.80 n 4.4 18 i

Earthquakes located offshore SE of the island Grímsey. No macroseismic information is available.

1969 May 5 2147 66.90–18.28 1 5.09 2 11 5.2 144 e

```
1969 May  5 2339 66.80-18.60  n            4.3    11 i
```

Earthquake epicentres located about 40 km NW of Grímsey.

```
1969 May  6 2356 66.55-18.00  n 3.8     1  4.5    11 i
```

Earthquake located south of Grímsey. We expect some reports on felt effects from the island. However, no macroseismic information is available.

```
1969 Aug 26 2240 66.54-17.70  3            4.3    23 i
1969 Aug 26 2247 66.44-17.51  8 4.33 1  7  4.9    57 e
1969 Aug 26 2349 66.51-17.80  n 4.11    1  4.4    19 i
1969 Aug 27 1212 66.50-17.70  n            4.4    23 i
```

An earthquake swarm located SE of Grímsey. No macroseismic information is available.

```
1970 Feb 08 1117 64.77-17.50  n            4.0    19 i
```

There is no report of this earthquake having been felt. It is located near the Bárdarbunga area in Vatnajökull Glacier.

```
1970 Jul 19 0501 62.81-24.60  n            4.0     9 i
```

An earthquake on the Reykjanes Ridge.

```
1970 Nov 06 0715 63.84-23.20  8 4.53 2  5  4.2    29 i
1970 Nov 06 1125 63.70-23.30  n 4.49 2  4  4.3    28 i
```

An earthquake sequence located offshore west of Reykjanes on the Reykjanes Ridge. The strongest earthquakes were felt from Flói in the East to Helgafellssveit on the Snæfellsnes Peninsula in the North.

[*Morgunbladid*, November 7, 1970]

```
1971 May 13 2008 63.90-23.20  n 4.16    1  4.4    12 i
```

An earthquake located offshore west of the Reykjanes Peninsula. No macroseismic information is available.

```
1971 Aug 29 1056 67.69-18.92 22 4.79 1 11  5.0   100 e
```

There are no reports of felt effects from this earthquake located about 140 km north of Grímsey.

```
1971 Nov 10 1528 63.90-22.00  n            4.1    15 r
```

An earthquake sequence starteded on the Reykjanes Peninsula. The strongest earthquakes were felt from Flói in the East to Helgafellssveit on the Snæfellsnes Peninsula. There was no damage in Reykjavík.

[*Morgunbladid*, November 11, 1971]

```
1971 Nov 19 0120 63.80-22.40  6              4.3    15 i
1971 Nov 19 0257 63.75-22.90  5 4.62 2  7  4.8    67 e
1971 Nov 19 0557 63.84-22.65 12 4.43 0  3  4.6    29 e
```

Continuing earthquake activity on the Reykjanes Peninsula and Reykjanes Ridge was reported. The strongest earthquakes were felt in Selfoss, Reykjavík and Akranes. The effects were most notable in the villages on the western part of the Reykjanes Peninsula. No damage was reported.

[*Morgunbladid*, November 20, 1971]

```
1971 Nov 28 1301 62.90-25.40  n              4.7    22 i
1971 Nov 28 1304 62.90-25.00  n              4.8    15 i
```

There was still earthquake activity on the Reykjanes Ridge but no felt report.

```
1972 Jan 01 1301 63.90-22.17  3 4.66    1  4.3    35 r
1972 Jan 01 1441 63.90-22.30  n              4.3    21 r
```

Earthquakes located on the Reykjanes Peninsula.

```
1973 Apr 01 0851 67.69-19.03 10 4.54    1  4.5    35 e
```

The earthquake location is about 140 km north of Grímsey.

```
1973 Apr 23 0257 64.57-17.70  5              4.2    28 i
```

The earthquake location is at Bárdarbunga in the Vatnajökull Glacier.

```
1973 Sep 15 0145 63.82-22.31  1 5.31 2 34  5.3   200 e
1973 Sep 15 0222 63.73-22.41  8 4.8     7  4.9    90 e
1973 Sep 16 2126 63.87-22.35  6 5.23 2 38  5.2   192 e
1973 Sep 16 2233 63.90-22.10  n 4.17 1  4  4.7    42 i
1973 Sep 17 0114 63.95-22.30  n              3.8    11 r
```

An earthquake swarm occurred on the Reykjanes Peninsula. The strongest earthquakes were perceptible over a large area from Hvolsvöllur in the East to Ísafjördur in the North. The effects were most significant in Grindavík and Krísuvík. There was significant damage to greenhouses in Krísuvík. Some people panicked. House articles and furniture toppled. Rocks fell from nearby mountains and blocked the road on the eastern part of the Reykjanes Peninsula.

[*Morgunbladid*, September 16, 1971]

```
1973 Oct 28 1001 66.93-19.39  n 3.8     1  4.5    27 i
1973 Oct 28 1042 67.04-19.40  n              4.1    30 i
1973 Oct 28 1048 67.13-19.20  n              4.3    41 i
1973 Oct 28 1053 67.14-19.40  n              4.3    18 i
1973 Oct 28 1112 67.12-19.17  6 4.19 2  9  4.7    62 e
1973 Oct 28 1115 67.07-19.40  n              4.3    23 i
```

```
1973 Oct 28 1125 67.03-19.20  n             4.2    20 i
1973 Oct 28 1131 67.11-19.06  3 4.61 1 20   5.2   107 e
1973 Oct 28 1147 67.13-19.06  n 4.0     1   4.6    36 i
1973 Oct 28 1201 67.37-19.00  n             4.2    28 i
1973 Oct 28 1425 67.18-19.25  n 4.27 1 12   4.5    48 i
```

There were no reports of an earthquake being felt. The epicentres are offshore, more the 80 km towards NW from Grímsey.

```
1974 Jan 15 1947 64.51-17.79  8 4.4     1   4.6    70 e
```

There is no mention of felt effects from this earthquake located near Mt. Hamarinn in the western Vatnajökull Glacier.

```
1974 Mar 30 1841 63.83-23.20  n 4.55    1   4.4    33 i
1974 Mar 30 1910 63.64-23.60  n 4.39    1   4.3    34 i
1974 Mar 30 2016 63.48-23.50  n 4.36 1  2   4.4    32 i
```

Earthquake swarm located on the Reykjanes Ridge. There were no reports of felt effects.

```
1974 May 11 0917 64.87-20.89 15 4.0         4.6    49 e
1974 May 17 1427 64.66-21.28  4 4.54 2  9   5.0   144 e
1974 May 18 2339 64.64-21.28 10 4.26 1  4   4.7    86 e
1974 Jun 12 1608 64.76-21.00  5 4.33 1  3   4.9    68 e
1974 Jun 12 1755 64.79-21.05 15 5.43 3 15   5.5   246 e
```

A sequence of earthquakes was felt very strongly in the upcountry in Borgarfjördur, where it caused some panic. There was damage on buildings and house articles. No injuries reported. The strongest earthquake was perceptible over the western part of the island.

[*Morgunbladid*, May-June, 1974]

```
1974 Jun 25 2223 64.66-17.60  9 4.85 4 18   5.1   212 e
```

There are not reported felt effects from this earthquake located near Bárdarbunga in the Vatnajökull Glacier.

```
1974 Oct 11 0912 67.45-20.24 11 4.40 1  4   4.6    81 e
```

An earthquake located approximately 150 km NW of Grímsey. There is no report of this earthquake being felt.

```
1974 Dec 08 0026 63.61-23.20  9             4.2    27 i
1974 Dec 08 0100 63.70-23.10  n             4.3    12 i
1974 Dec 08 0126 63.65-22.90 28             4.2    15 i
```

Earthquake swarm located on the Reykjanes Ridge. Felt effects were not reported.

1974 Dec 29 0350 64.54-17.61 12 5.96 2 12 5.1 181 e

An earthquake located in the western part of the Vatnajökull Glacier. There are not reported felt effects.

1975 Mar 11 2342 66.20-18.57 13 4.16 1 9 4.5 59 e

This earthquake is located offshore, north of Eyjafjördur. No macroseismic information is available.

1975 Aug 13 1006 66.59-17.98 n 4.15 0 3 4.5 36 i

An earthquake located near to Grímsey. We expect some felt reports from the island but did not find any.

1975 Sep 27 2245 62.03-26.70 n 4.7 27 i

This event is located on Reykjanes Ridge, about 280 km SW of Reykjanes.

1975 Oct 03 1834 64.50-17.42 6 5.0 5 5.1 185 e

An earthquake located in the western part of the Vatnajökull Glacier. No macroseismic information is available.

1975 Dec 16 0357 66.50-18.08 10 4.0 1 4.6 36 e

This event is located near Grímsey. No macroseismic information is available.

1975 Dec 23 1540 63.87-22.50 5 4.74 1 4.5 33 r
1975 Dec 23 1606 63.91-22.09 n 4.60 1 4.5 34 i

Earthquakes on the Reykjanes Peninsula were felt in Selvogur, Hafnarfjördur, Reykjavík and even in Borgarfjördur. They were barely felt in Grindavík and Hveragerdi. The macroseismic epicentres were in Brennisteinsfjöll north of Selvogur.

[*Morgunbladid*, December 24, 1974]

1975 Dec 24 0933 66.03-16.90 7 4.39 1 4.7 73 e
1975 Dec 24 1741 66.02-17.12 34 4.5 1 4.8 29 i
1975 Dec 25 0544 66.07-17.07 10 3.8 1 4.5 18 i
1975 Dec 25 2204 66.26-16.41 5 4.89 4 15 5.0 169 e
1975 Dec 26 0050 65.99-16.92 1 4.5 1 4.8 65 e
1975 Dec 26 1656 66.13-16.86 10 4.3 1 4.7 26 i
1975 Dec 26 2031 66.12-17.30 n 4.4 22 i
1975 Dec 29 1045 66.05-16.91 2 5.11 2 6 4.7 75 e
1975 Dec 30 1505 66.01-16.90 10 3.8 1 4.5 26 i
1976 Jan 01 0032 66.10-16.76 2 4.48 1 4.8 58 e

1976 Jan 04 0429 66.09–16.70 6 4.81 1 13 5.2   119 e

Earthquakes were felt strongly in Kelduhverfi and Öxarfjördur. The earthquake activity in Kelduhverfi and at the central volcano Krafla started a few months earlier, i.e., in September. It resulted in surface fractures, stretching over more than 40 km, and vertical movements of the ground, damaging roads in Öxarfjördur. Furthermore, there was earthquake-induced damage to houses in Öxarfjördur. Some people panicked. A few of the earthquakes were strongly felt in Húsavík.

A volcanic eruption started in Leirhnúkur on 20 December. The accompanying earthquakes induced large cracks in the 'masonry' walls of one house in Reykjahlíd. The earthquake activity in the area continued in the days following and culminated in the so-called Kópasker Earthquake.

[*Morgunbladid*, December 23 and December 28, 1975; *Skjálftabréf*, No. 6, 1976; Einarsson, 1991]

1976 Jan 06 0850 65.75–16.79 28 4.35 1 6 4.9   104 e
1976 Jan 06 2301 66.09–16.73 26 4.5   1 4.7   50 e
1976 Jan 09 0346 66.06–16.72 1 4.72 3 3 4.8   84 e
1976 Jan 09 0645 65.95–16.74 8 4.6   1 4.7   65 e
1976 Jan 13 0434 66.09–16.92 1 5.0   7 5.0   97 e

Earthquakes were felt strongly in Kelduhvefi and at the Krafla Power Plant, under construction at that time. Permanent crustal movements, resulting in settlements of the land in Kelduhverfi accompanied the earthquakes.

[Einarsson, 1991; *Morgunbladid*, January 7, 1976; *Skjálftabréf*, No. 7, 1976]

1976 Jan 13 1329 66.28–16.57 4 6.33 2 16 5.9   353 e

A destructive earthquake induced severe damage in the village of Kópasker and the neighbouring areas. The meizoseismal region is indicated in Figure 6.14. There was significant ground deformation and settlement. A small lake near the village dried up. A majority of the buildings suffered some structural damage, the most severe being in the area of active faults. There was extensive damage to inventory and an outage of electricity due to broken service conductors. The water supply to the village was interrupted. A concrete quay in the harbour cracked and settled. There was general panic. Children and women were evacuated. The earthquake was felt over most of the island. In the following days, the earthquake activity in the area persisted.

[*Morgunbladid*, January 14 and 15, 1975; *Skjálftabréf*, No. 7, 1976; Einarsson, 1971; Vidlagatrygging, 1976]

1976 Jan 13 1626 66.09–16.67 9 4.5   1 4.7   50 e
1976 Jan 14 0905 65.73–16.71 10 3.8   1 4.5   31 i
1976 Jan 15 0016 66.14–16.72 10 3.8   1 4.5   21 i

Figure 6.14 – Meizoseismal region (marked by a red curve) of the Kópasker Earthquake on 13 January 1976 (based on Thráinsson [1992]).

```
1976 Jan 17 1151 65.68-17.00 15 3.9      1  4.5    50 e
```

People were evacuated from the Krafla Power Plant during the night due to increasing earthquake activity in the area. This activity continued the next several days.
[*Morgunbladid*, January 17, 1976]

```
1976 Jan 18 0823 65.69-16.95 10 4.48 1  4  4.7    62 e
1976 Jan 19 0922 65.69-16.95 17 4.90 2 12  4.9   107 e
1976 Jan 20 0445 65.70-16.79  9 4.0      1  4.6    37 e
1976 Jan 21 1432 65.74-16.77 10 4.7      5  4.7    71 e
1976 Jan 22 2056 65.78-16.71  n 3.8      1  4.5    26 i
1976 Jan 31 2240 65.64-16.90 10 4.72 1 12  4.7    72 e
```

The continuing earthquake activity in Öxarfjördur and in the Krafla area appeared to decrease towards the end of January.
[*Morgunbladid*, February 1, 1976]

```
1976 Feb 02 1316 66.10-16.74  1 4.81 2 16  4.8   115 e
```

An earthquake was felt strongly in Öxarfjördur and the neighbouring areas.
[*Morgunbladid*, February 3, 1976]

```
1976 Mar 06 2027 66.57-17.89  1 4.71 0  3  4.6    90 e
```

This event is located close to Grímsey. Felt in Grímsey, Siglufjördur and in the coastal area in North Iceland.
[*Skjálftabréf*, No. 9, 1976]

```
1976 Jul 27 0401 64.69-17.38  1 5.00 2 12  5.1   228 e
```

This event is located near to Bárdarbunga in the Vatnajökull Glacier. There were no reports of an earthquake being felt.

```
1977 Jan 20 0257 65.70-16.80  5             4.2    18 r
1977 Jan 20 0434 65.74-16.83 10             4.2    27 i
```

The workers at the Krafla Power Plant were evacuated.
[*Morgunbladid*, January 20, 1977; *Skjálftabréf*, No. 19, 1977]

```
1977 Mar 24 0925 63.65-19.10  5             4.7    25 r
```

This earthquake was felt in settlements in Mýrdalur, especially near the Katla Volcano.
[*Morgunbladid*, March 25, 1977]

```
1977 May 16 1648 63.91-22.31  8 4.81 2 18  4.6    67 e
1977 May 16 1658 63.96-22.00 10 4.9      1  4.0    21 i
```

A rather strong earthquake swarm occurred on the Reykjanes Peninsula. House articles fell from shelves and toppled at the Reykjanes Lighthouse.
[*Morgunbladid*, May 17, 1977]

1977	**Jun**	**02**	**1455**	**63.63-19.18**	**1**	**5.10**	**2**	**29**	**4.9**	**172**	**e**

This was felt in settlements in Mýrdalur, especially near the Katla Volcano.
[*Morgunbladid*, June 3, 1977]

1977	**Jul**	**01**	**1831**	**64.61-17.80**	**5**	**3.97**		**1**	**3.8**	**25**	**i**
1977	**Jul**	**14**	**0715**	**64.46-17.57**	**29**	**4.5**		**1**	**4.8**	**72**	**e**

Earthquakes located near to Grímsvötn in the Vatnajökull Glacier. No felt effects reported.
[*Skjálftabréf*, No. 24, 1977]

1977	**Dec**	**28**	**2032**	**64.63-17.38**	**1**	**5.05**	**3**	**18**	**5.2**	**190**	**e**

An earthquake located in the western part of the Vatnajökull Glacier near to Bárdarbunga. No macroseismic information is available.
[*Skjálftabréf*, No. 28, 1977]

1978	**Jan**	**09**	**0915**	**65.91-16.99**	**1**	**4.18**		**1**	**4.3**	**31**	**e**
1978	**Jan**	**09**	**1354**	**65.95-16.98**	**10**	**4.39**	**2**	**2**	**4.4**	**34**	**i**
1978	**Jan**	**09**	**1903**	**65.97-16.89**	**6**	**4.66**	**2**	**4**	**4.6**	**59**	**i**
1978	**Jan**	**09**	**2002**	**65.98-17.00**	**13**	**3.83**		**1**	**4.2**	**30**	**i**
1978	**Jan**	**10**	**0156**	**65.98-17.00**	**10**	**4.27**		**1**	**4.2**	**27**	**i**
1978	**Jan**	**10**	**1039**	**66.01-16.80**	**10**	**3.63**		**1**	**4.1**	**17**	**i**
1978	**Jan**	**10**	**1245**	**65.94-16.64**	**15**	**3.83**		**1**	**4.5**	**49**	**e**
1978	**Jan**	**10**	**1742**	**65.98-17.00**	**10**	**4.65**	**2**	**7**	**4.8**	**61**	**e**
1978	**Jan**	**10**	**1925**	**66.03-16.80**	**10**	**3.56**		**1**	**4.3**	**22**	**i**
1978	**Jan**	**10**	**2045**	**65.89-16.88**	**7**	**4.6**		**1**	**4.7**	**54**	**e**
1978	**Jan**	**11**	**1058**	**65.95-16.91**	**9**	**4.40**	**1**	**3**	**4.8**	**79**	**e**
1978	**Jan**	**13**	**0031**	**66.01-16.94**	**3**	**4.00**	**3**	**3**	**4.7**	**34**	**e**

An earthquake swarm occurred in Öxarfjördur. Roads were damaged.
[*Morgunbladid*, January 10, 1979].

1978	**May**	**3**	**2359**	**64.73-17.40**	**10**				**3.9**	**22**	**i**

An event located near Bárdarbunga in the Vatnajökull Glacier. There were no reports of an earthquake being felt.

1978	**May**	**17**	**0943**	**62.76-25.30**	**10**				**4.2**	**24**	**i**

An earthquake located on the Reykjanes Ridge. There were no reports of this earthquake being felt.

```
1978 Jun 21 2329 64.64-17.60  n              4.0    29 i
```

An earthquake located at Bárdarbunga. There were no felt reports.

```
1978 Jul 12 1759 66.05-16.80  n              4.0    27 r
```

An event in an earthquake swarm originating in the Krafla area. There were no reports on damage.

```
1978 Sep 06 1923 64.45-18.20 10 3.99    1  4.0    27 i
```

An earthquake located west of Vatnajökull. There were no reports of felt effects.

```
1979 Apr  1 0431 64.51-17.60  5 3.10    1  4.0    36 i
```

An earthquake located south of Bárdarbunga.

```
1979 Apr 30 2328 66.53-17.95 10 3.59    1  4.2    43 i
```

This earthquake is located close to Grímsey. We did not find any report of expected felt effects.

```
1979 Jun 22 2318 64.53-17.55  7 4.94 3 48  5.4   282 e
1980 May 05 1322 64.51-17.50 10 3.05    1  4.0    23 i
```

Earthquakes located south of Bárdarbunga.

```
1980 May 17 2115 63.15-24.49 10 3.85    1  4.5    48 i
```

An earthquake with epicentre located on the Reykjanes Ridge.

```
1980 Aug 12 1211 64.69-17.33 26 5.14 2 41  5.3   242 e
```

An event located near to Bárdarbunga.

```
1980 Aug 20 1425 62.70-25.33 20 4.52 3 17  4.8   130 e
1980 Aug 20 1506 62.70-25.28  9 4.54 2 14  4.4    82 e
```

Events located on the Reykjanes Ridge. There were no reports of an earthquake being felt.

```
1980 Dec 25 1137 66.51-17.68 12 4.77 1 18  5.2   168 e
1980 Dec 25 1144 66.56-17.74 10 3.87    1  4.6    46 e
1980 Dec 25 1157 66.63-17.38 10 3.40    1  4.5    12 i
1980 Dec 25 1747 66.47-17.77 10            4.7    37 e
```

These events are located in the area east of Grímsey. There were no reports of an earthquake being felt.

```
1980 Dec 26 0045 55.50-17.86 10 3.11    1  4.5    23 i
```

This earthquake is outside our study area. There were no reports of an earthquake being felt.

```
1980 Dec 26 0146 66.39-18.17 10 3.60    1  4.5    23 i
1980 Dec 26 0501 66.38-18.04 12 3.85    1  4.5    27 i
1980 Dec 26 0503 66.48-17.84  8 4.34 4  3  4.8    55 e
```

These events are located in the area south of Grímsey. There were no reports of an earthquake being felt.

```
1981 May 09 0131 64.58-20.90 10            4.4    20 i
```

An earthquake was felt in Laugarvatn and the upcountry in Borgarfjördur. This was the largest earthquake in an earthquake sequence with a macroseismic epicentre near Thorisjökull.

[*Skjálftabréf*, No. 48, July 1981]

```
1981 Jul 12 1806 62.94-25.10 10            4.2    23 i
1982 Nov 08 1243 62.70-24.55  1 4.43 3  7  4.6    55 e
1982 Nov 08 1637 63.20-25.70 10            4.6    20 i
```

Earthquakes located on the Reykjanes Ridge. There were no reports of an earthquake being felt.

```
1983 Apr 06 1358 61.80-25.60 10 4.50 2  3  4.5    66 i
1983 Apr 06 1414 62.47-25.89  6 4.4     1  4.8    89 e
1983 May 16 1535 63.51-23.74  1 4.55 2  6  4.6    67 e
1983 May 16 1542 63.52-23.48  5 4.81 2 19  4.9   121 e
1983 Jul 11 1942 63.47-23.90  4 4.12 2  2  4.6    59 e
1983 Jul 11 2026 63.36-23.91  1 4.69 2  6  4.7    78 e
```

An earthquake sequence located on the Reykjanes Ridge. There were no reports of an earthquake being felt.

```
1983 Jul 20 0944 64.46-17.81 10 4.59 0  2  4.6    48 i
```

An event with epicentre located near to Mt. Hamarinn in the Vatnajökull Glacier. There were no reports of an earthquake being felt.

```
1984 Feb 22 1830 64.35-20.60 10 4.0     1  4.5    41 i
```

An earthquake in Skjaldbreidur was widely felt in Southwest Iceland and was followed by many aftershocks.

[*Morgunbladid*, February 23, 1993; *Skjálftabréf*, No. 58, June 1984]

1984 Apr 24 0822 62.97-24.89 15 4.46 2 10 4.7 101 e

There were no reports of this earthquake being felt. It is located on the Reykjanes Ridge.

1984 Sep 30 2332 64.56-17.55 3 4.77 2 43 5.2 244 e

An event located south of Bárdarbunga in the Vatnajökull Glacier. No macroseismic data are available.

1984 Nov 10 0840 61.78-29.21 10 5.02 3 38 5.0 225 i

There were no reports of an earthquake being felt. An earthquake swarm occurred near Jan Mayen, starting on 6 January 1985, 07h 57m. A volcanic eruption occurred on Jan Mayen.

[*Skjálftabréf*, No. 60, May 1985]

1985 Jan 13 2115 63.09-24.40 10 4.3 25 i

1985 Feb 20 1510 62.81-25.04 10 4.0 1 4.6 63 e

No macroseismic data are available for these events on Reykjanes Ridge.

1985 Jun 25 1031 64.61-20.78 8 4.60 2 20 4.4 82 e

An earthquake swarm occurred in Geitlandsjökull Glacier (at the western part of Langjökull Glacier). It was felt in the Borgarfjördur upcountry and in Laugarvatn.

[*Skjálftabréf*, No. 61, November 1985]

1985 Jun 26 1339 64.67-20.80 10 3.93 2 4 4.3 54 i

An earthquake occurring at Mt. Hafrafell near the west edge of Langjökull Glacier was felt in the upcountry in Borgarfjördur as well as the upcountries in South Iceland.

[*Skjálftabréf*, No. 61, November 1985]

1985 Jun 28 1644 64.53-20.90 3 3.69 0 2 4.3 41 i

An earthquake occurring in the Geitlandsjökull Glacier (at the western part of the Langjökull Glacier) was felt in Hvítársída and was perceptible in the upcountry in Borgarfjördur and the Árnessýsla District.

[*Morgunbladid*, June 29, 1985; *Skjálftabréf*, No. 61, November 1985]

1985 Jul 01 0014 61.20-25.60 10 4.1 25 i

This event is located on the Reykjanes Ridge. There were no reports of an earthquake being felt.

```
1985 Jul 19 1723 64.00-21.60  n              4.2    22 r
```

An earthquake occurring near the west edge of Langjökull Glacier was strongly felt in the upcountry of Borgarfjördur. It was perceptible from Borgarnes to the upcountry of the Árnessýsla District. The earthquake was followed by a series of aftershocks.

[*Morgunbladid*, July 20, 1985; *Skjálftabréf*, No. 61, November 1985]

```
1985 Aug 30 1847 67.71-19.01 10 4.36 2  8  4.6    28 i
1985 Aug 30 1901 67.65-18.88 15 4.71 1 19  5.0   129 e
1985 Dec 24 1052 67.73-18.70 10 4.02 1  2  4.6    38 i
```

These events are located about 140 km north of Grímsey. There were no reports of an earthquake being felt.

```
1986 Apr 02 0841 62.63-25.37 10 4.47    1  4.6    68 e
1986 Apr 02 0844 62.81-25.21  7 4.1     1  4.6    65 e
1986 Apr 02 0846 62.69-25.28 10 4.89 3 28  5.0   191 e
1986 Apr 02 0849 62.60-25.20 10            4.3    24 i
1986 Apr 02 0859 62.73-25.27  8 4.60 1 10  4.8   121 e
1986 Apr 02 1526 62.66-25.36  5 4.78 2 31  5.2   271 e
1986 Apr 02 1740 62.60-25.44  6 4.59 3  5  4.8   126 e
1986 Apr 02 1749 62.65-25.29 12 5.00 2 38  5.1   264 e
1986 Apr 02 1802 62.60-25.27 10 3.8     1  4.5    33 e
1986 Apr 02 2035 62.40-25.70  n 3.68    1  4.2    32 i
1986 Aug 03 0137 62.47-25.81  9 4.0     1  4.6    43 e
1986 Sep 16 1418 63.36-24.05  n 4.39 4  6  4.5    37 i
```

There were no reports of an earthquake being felt. An earthquake swarm occurred on the Reykjanes Ridge.

[*Skjálftabréf*, No. 63, 1987].

```
1986 Oct 12 2334 66.21-17.43  n 3.71 3  2  4.2    39 i
```

An earthquake swarm with epicentre south-east of Grímsey was felt from Skagafjördur in the West to Vopnafjördur in the East. The effects were most noticeable in Grímsey and in the northernmost part of Eyjafjördur. There are no reports on damage.

[*Morgunbladid*, October 14, 1986]

```
1986 Oct 21 0859 61.80-25.70  n 3.7     1  4.5    24 i
```

An earthquake located on Reykjanes Ridge. There were no reports of an earthquake being felt.

1986 Nov 23 0249 64.65-17.35 7 5.12 2 6 5.2 244 e

An earthquake occurred in Bárdarbunga (at the Vatnajökull Glacier). There were no reports of an earthquake being felt.

[*Skjálftabréf*, No.63, April 1987]

1987 May 25 1132 63.91-19.79 8 5.95 2 58 5.7 483 m

The so-called Vatnafjöll Earthquake was felt throughout South Iceland. Some people panicked. There was minor damage to a traditional farmhouse at Keldur in Rangarvellir. There was rockfall from mountains and avalanches on Mt. Hekla. The earthquake was felt in Reykjavík and was perceptible from Sudursveit to Grindavík and even in Akureyri. A tentative intensity map is shown in Figure 6.15. Both for- and aftershocks accompanied the earthquake.

[*Morgunbladid*, May 26, 1988; *Skjálftabréf*, No. 65, April 1988; *Mánadaryfirlit jardskjálfta*, May, 1987]

1987 Jul 01 1756 64.72-17.67 7 3.64 0 3 4.3 65 e

An event located near to Bárdarbunga. There were no reports of an earthquake being felt.

1987 Sep 16 0237 66.53-18.30 n 4.3 26 i

This was the biggest earthquake in an earthquake swarm near Grímsey lasting several months. It was felt in Siglufjördur, Dalvík and on farms on the west coast of Skjálfandaflói.

[*Skjálftabréf*, No. 64, March 1988]

1988 Sep 09 1441 66.59-18.09 3 4.22 3 5 4.4 55 e
1988 Sep 12 2019 66.64-17.84 6 4.55 2 30 4.7 186 m
1988 Sep 12 2300 66.60-18.40 n 3.41 1 4.2 25 i

Earthquakes were strongly felt in Grímsey. The biggest earthquake was perceptible from Saudárkrókur to Vopnafjördur.

[*Morgunbladid*, September 10 and 13, 1985]

1989 Feb 03 1440 64.64-17.50 n 4.1 26 i
1989 Feb 03 1518 64.56-17.43 2 4.95 3 13 5.2 350 e
1989 May 06 2346 64.70-17.45 n 4.26 1 2 4.3 20 i

An earthquake sequence occurred in Bárdarbunga (at the Vatnajökull Glacier). There were no reports of an earthquake being felt.

1990 Mar 19 1046 63.95-21.93 6 4.68 1 19 4.7 138 m

An earthquake swarm occurred on the Reykjanes Peninsula. There was some minor damage in Krísuvík. It was widely felt in the Reykjavík area. The biggest

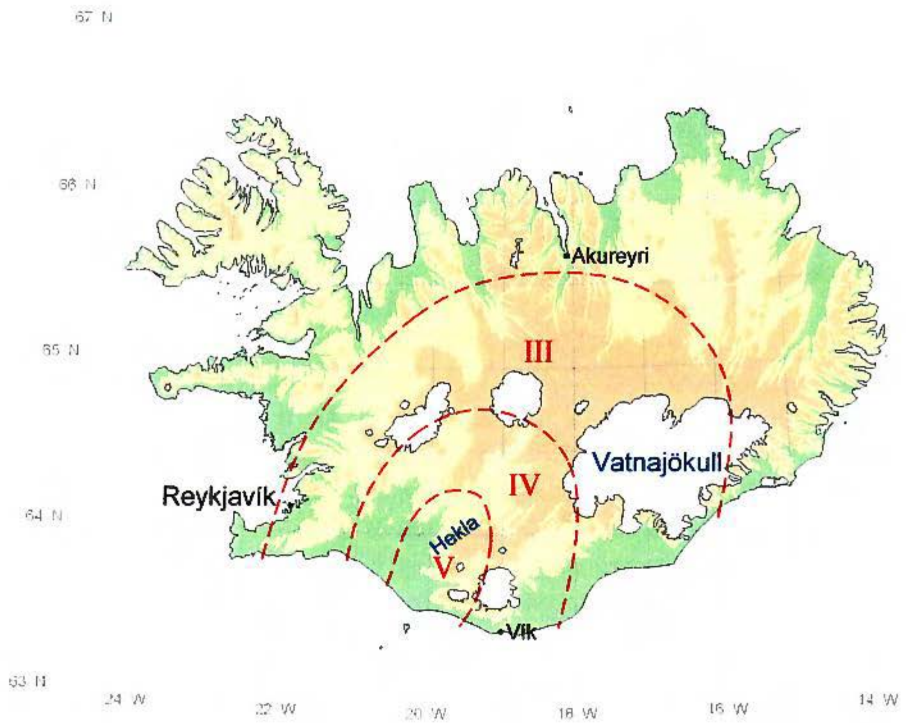

Figure 6.15 – Isoseismals of the Vatnafjöll Earthquake on 25 May 1987 (based on macroseismic information reported in *Skjálftabréf*, No. 65, 1987).

earthquake was perceptible from Austur-Landeyjar to Búdardalur. The macroseismic epicentre was west of Lake Kleifarvatn.

[*Morgunbladid*, March 20, 1990]

1990	May	26	0256	63.00-24.72	19	4.23	3	5	4.5	57	e
1990	May	30	0612	62.80-25.50	n				4.2	37	i

An earthquake swarm located on the Reykjanes Ridge. There were no reports of an earthquake being felt.

1990	Sep	15	1752	63.81-22.48	n	4.00	2	5	4.3	50	i

An earthquake swarm was felt in the settlements on the Reykjanes Peninsula and was perceptible in Reykjavík.

[*Morgunbladid*, September 18, 1990]

1990	Sep	15	2307	64.65-17.60	21	5.34	3	96	5.3	333	e

An earthquake located in Bárdarbunga. There were no reports of an earthquake being felt.

1990	Mar	19	1046	63.95-21.93	6	4.68	1	19	4.7	138	m
1990	May	26	0256	63.00-24.72	19	4.23	3	5	4.5	57	e
1990	May	30	0612	62.80-25.50	n				4.2	37	i
1990	Sep	15	1752	63.81-22.48	n	4.00	2	5	4.3	50	i
1990	Sep	15	2307	64.65-17.60	21	5.34	3	96	5.3	333	e
1990	Oct	30	1230	63.03-24.56	1	4.63	2	14	4.8	67	e
1990	Oct	30	1254	63.08-24.66	5	4.00	0	2	4.6	28	i
1990	Oct	30	1307	63.38-24.11	10	4.28	1	4	4.8	46	e
1990	Oct	30	1336	62.96-24.14	5	4.20	1	4	4.8	28	i
1990	Oct	30	1358	63.26-24.34	10	4.33	1	8	4.9	55	e
1990	Oct	30	1403	63.16-24.29	3	4.55	1	12	4.9	94	e
1990	Oct	30	1547	63.32-24.06	5	4.38	0	2	4.7	16	i
1990	Oct	30	1916	63.22-24.23	13	4.36	1	7	4.8	77	e
1990	Oct	30	2123	63.28-24.21	10	4.62	2	12	4.7	46	e
1990	Oct	30	2310	63.18-24.33	5	3.72	1	2	4.6	23	i
1990	Oct	30	2348	63.13-24.41	n	3.86	0	3	4.7	32	i
1990	Oct	31	0051	63.21-24.16	10	4.39	2	10	4.9	76	e
1990	Oct	31	0344	63.08-24.78	5	4.14	1	4	4.7	29	i
1990	Oct	31	0400	63.32-24.66	5	4.05	0	3	3.7	28	i
1990	Oct	31	0450	63.14-24.63	10	3.88	0	3	4.7	27	e
1990	Oct	31	0552	63.24-24.55	5	3.79	1	2	4.7	14	i
1990	Oct	31	0623	63.23-23.93	5	3.73	1	2	4.7	21	i
1990	Oct	31	0658	63.28-24.23	15	3.87	0	2	4.7	56	e
1990	Oct	31	0839	63.26-24.30	5	3.52		1	4.6	20	i

1990 Nov 03 1426 63.60-24.00 n 3.67 0 4 4.3 25 i
1990 Nov 05 1720 63.09-24.17 10 3.88 1 4 4.3 34 e

Great earthquake activity occurred on the Reykjanes Ridge, culminating 30 October. There were, however, no reports of an earthquake being felt.

1990 Dec 29 0257 68.40-18.20 10 4.8 30 i

An event located roughly 200 km north of Grímsey. There were no reports of an earthquake being felt.

1991 Jan 30 0743 64.38-20.75 19 4.77 2 26 5.1 145 m

An earthquake was felt strongly in Thingvellir and Laugarvatn. No damage was reported. It was perceptible from Vík to Búdardalur. The macroseismic epicentre was in Skjaldbreidur. From Thingvellir shortly after the earthquake, a 'fire' was seen in the sky.
[*Morgunbladid*, January 31, 1991]

1992 Apr 25 0648 64.65-17.39 9 4.67 3 21 4.8 232 e
1992 Sep 26 0545 64.66-17.60 9 5.38 2 128 5.4 382 e

Events located near Bárdarbunga. There were no reports of an earthquake being felt.

1992 Dec 27 1223 64.00-21.20m 3 3.73 1 4 4.3 35

An earthquake was felt widely in Southwest Iceland and most strongly in Hveragerdi. Some people panicked. House articles moved and fell from shelves, but there was no significant damage. The quake was perceptible from Vík to Dalir. There was a macroseismic epicentre in the Hengill area (at Hellisheidi).
[*Morgunbladid*, December 29, 1992]

1993 Jun 22 1233 64.71-17.30 7 4.96 2 88 5.1 257 e

An earthquake located in Bárdarbunga. There were no reports of an earthquake being felt.

1993 Aug 28 1959 65.97-17.94 15 4.1 33 m

This was strongly felt in Dalvík and perceptible in the central part of North Iceland. A macroseismic epicentre was on the Flateyjardalsheidi Heath.
[*Morgunbladid*, August 31, 1993]

1994 Feb 08 0327 66.47-19.25 17 5.46 2 103 5.2 358 e

This event with an epicentral location offshore was felt at Siglufjördur.

```
1994 May 05 0514 64.52-17.52  9 5.28 2 106 5.5   460 e
```

This event is located south of Bárdarbunga. There were no reports of an earthquake being felt.

```
1994 May 31 2323 68.10-20.60  n            4.2    24 i
1994 May 31 2355 67.40-19.80  n            3.9    20 i
```

There were no reports of an earthquake being felt.

```
1994 Jul 22 0045 64.65-20.80  n            4.1    23 i
```

There were no reports of an earthquake being felt. The epicentre was reported in Kaldidalur.

[*Morgunbladid,* June 24, 1994].

```
1994 Aug 20 1640 64.03-22.34 10            4.2    27 m
```

An earthquake swarm, occurring in the Hengill area, was strongly felt in Hveragerdi. The biggest shock was perceptible from Fljótshlíd to Akranes. No significant damage as reported.

[*Morgunbladid*, August 14-21, 1994]

```
1994 Nov 18 2354 64.50-17.70 10            4.2    27 i
```

This earthquake is located near Bárdarbunga in the Vatnajökull Glacier. There were no reports of an earthquake being felt.

```
1994 Dec 20 2351 68.67-17.50  6            4.5    43 i
```

There were no reports of an earthquake being felt.

```
1995 Feb 02 1521 62.41-25.49 11 4.0     4  4.5    89 e
```

There were no reports of an earthquake being felt. This epicentre is deep offshore on the Reykjanes Ridge.

```
1995 Nov 18 0156 64.70-17.40 10 3.7     2  4.2    48 e
1995 Dec 11 0522 64.59-17.74 10 4.39 2 12  4.9   171 e
```

There were no reports of an earthquake being felt. The epicentres are in the north-western part of the Vatnajökull Glacier, near the central volcano Bárdarbunga.

7. DISCUSSION

In what follows we discuss some of the properties of the parametric earthquake catalogue presented in Table 5.1 (pages 26 to 36). This includes a presentation of the spatial and temporal distribution of earthquakes, statistical distribution of surface wave magnitudes as well as formulas relating the surface wave magnitude to the seismic moment.

Temporal and spatial distribution of earthquake data – It is in general expected that spatial and temporal distributions of earthquakes are non-uniform. This is clearly seen in Figures 7.1 and 7.2 showing, respectively, the spatial distribution of earthquakes and the temporal distribution of earthquakes within the study area. Both figures are based on data derived from the parametric catalogue listed in Table 5.1. The spatial distribution of earthquakes seems to reflect properties similar to the findings by other researchers (see, for instance, Björnsson and Einarsson [1974]).

The temporal distributions of earthquakes, displayed in Figure 7.2, show a broadly increasing average number of earthquakes with time. This is to be expected since the number and sensitivity of instruments has been increasing during the period considered. Nonetheless, there are some noteworthy fluctuations in the number of earthquakes during the study period, which can be seen by examining the curves displayed in Figure 7.2. The black curve shows the number of earthquakes each year, centring the classes around 1896, 1897 and so on. The blue curve shows the average number of earthquakes every five years, the classes covering 1896 to 1901, 1901 to 1906, and so on. The red curve shows the average number of earthquakes every ten years, the classes covering 1896 to 1906, 1906 to 1916, and so on.

The study period starts with high earthquake activity that apparently decreases after the 1912 earthquake in South Iceland. Thereafter, the activity culminates during the period of the Dalvik Earthquake in 1934. The next culmination in number of earthquakes is during the Krafla Eruption, starting with the destructive Kópasker Earthquake in 1976. After this highly active period the number of earthquakes has been decreasing on the average, as can be seen if we take a look at the red or the blue curve in Figure 7.2. However, if we look at the black curve, reflecting the number of earthquakes each year, there are some noteworthy fluctuations during the last 20 years of our study period. Here, it is especially worth observing that the number of catalogued earthquakes in the year 1990 is the highest during our study period, or 27. The majority of these earthquakes had epicentres on the Reykjanes Ridge. It we look at the last 30 years of our study period, we see that the western part of Vatnajökull has been rather active.

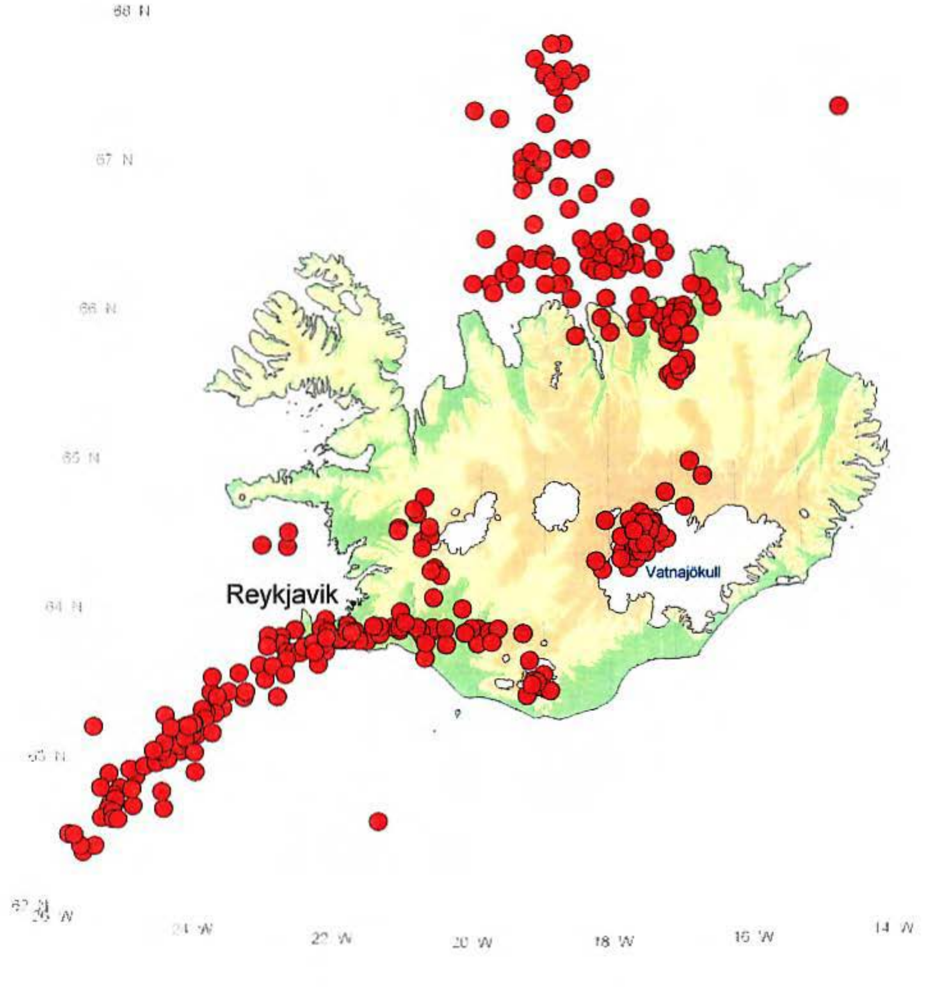

Figure 7.1 - The spatial distribution of earthquakes within the study area.

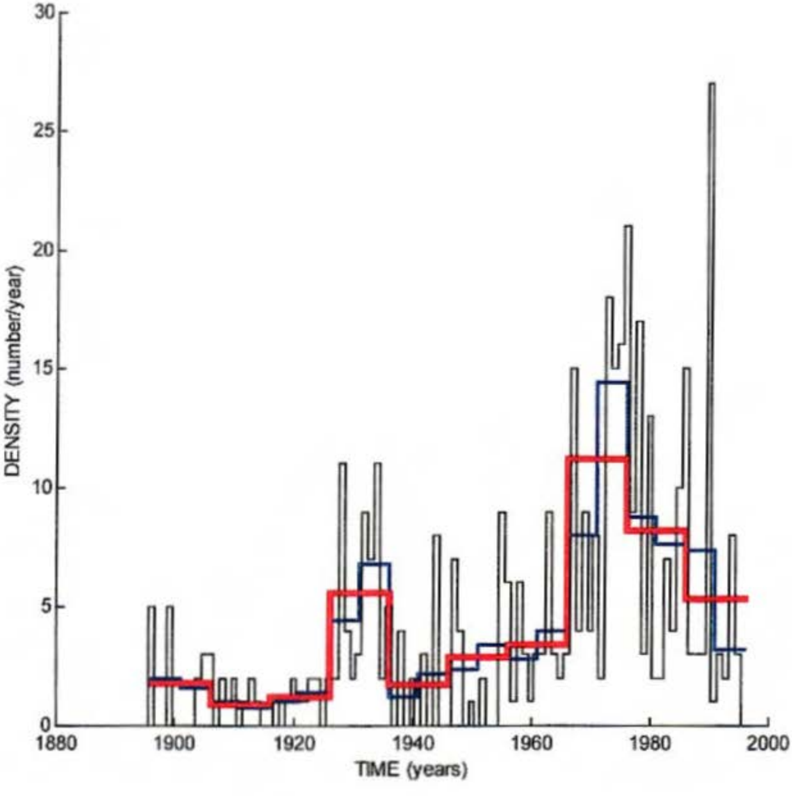

Figure 7.2 - The temporal distribution of earthquakes within the study area. The black curve shows the number of earthquakes each year, centring the classes around 1896, 1897 and so on. The blue curve shows the average number of earthquakes every five years, the classes covering 1896 to 1901, 1901 to 1906, and so on. The red curve shows the average number of earthquakes every ten years, the classes covering 1896 to 1906, 1906 to 1916, and so on.

Magnitude distribution – It can be deduced from the case histories (see Chapter 6) that the presented parametric earthquake catalogue contains different types of earthquakes occurring within our study area. Without going into detail, it seems obvious, for instance, that the catalogue contains earthquakes related to volcanic activity as well as earthquakes of more direct tectonic origin.

Based on this observation, it is suggested that the magnitude distribution function can be obtained by approximating the parent earthquake population as a mixture of at least two different, exponentially distributed populations. Let us denote these hypothetical populations No.1 and No.2, and let us furthermore assume the magnitudes of the earthquakes belonging to population No.1 to be smaller than those belonging to population No.2. Then the following density functions are obtained:

$$n_1 = \alpha_1 \exp(-\beta_1 M); \qquad M_{1,\min} \le M < M_{1,\max} \tag{7.1}$$

and

$$n_2 = \begin{cases} \alpha_2 \exp(-\beta_2 M); & M_{2,\min} \le M < M_{2,\max} \\ \chi_2; & M_{2,\max} \le M < M_{2,\max} + \Delta M \end{cases} \tag{7.2}$$

Here, $M_{1,\min}$, $M_{1,\max}$, $M_{2,\min}$, $M_{2,\max}$, ΔM, α_1, β_1, α_2, β_2 and χ_2 are model parameters. The parameter χ_2 is included to account for uncertainties in the magnitude determination. Hence, the compound density function of the total data set can be expressed as:

$$n = \begin{cases} \alpha_1 \exp(-\beta_1 M) + \alpha_2 \exp(-\beta_2 M); & M_{1,\min} \le M < M_{2,\max} \\ \chi_2; & M_{2,\max} \le M < M_{2,\max} + \Delta M \end{cases} \tag{7.3}$$

A special case of this density function is the log-bilinear distribution introduced by Ambraseys and Sarma [1999], obtained when $M_{1,\max} = M_{2,\min}$ and $\chi_2 = 0$.

The cumulative distribution derived from Eq. (7.3) is given as follows:

$$N = \begin{cases} \dfrac{\alpha_1}{\beta_1}\left(\exp(-\beta_1 M) - \exp(-\beta_1 M_{1,\max})\right) \\ \quad + \dfrac{\alpha_2}{\beta_2}\left(\exp(-\beta_2 M) - \exp(-\beta_2 M_{2,\max})\right) + \chi_2 \Delta M; & M_{1,\min} \le M < M_{2,\max} \\ \chi_2 (M_{2,\max} + \Delta M - M); & M_{2,\max} \le M < M_{2,\max} + \Delta M \end{cases} \tag{7.4}$$

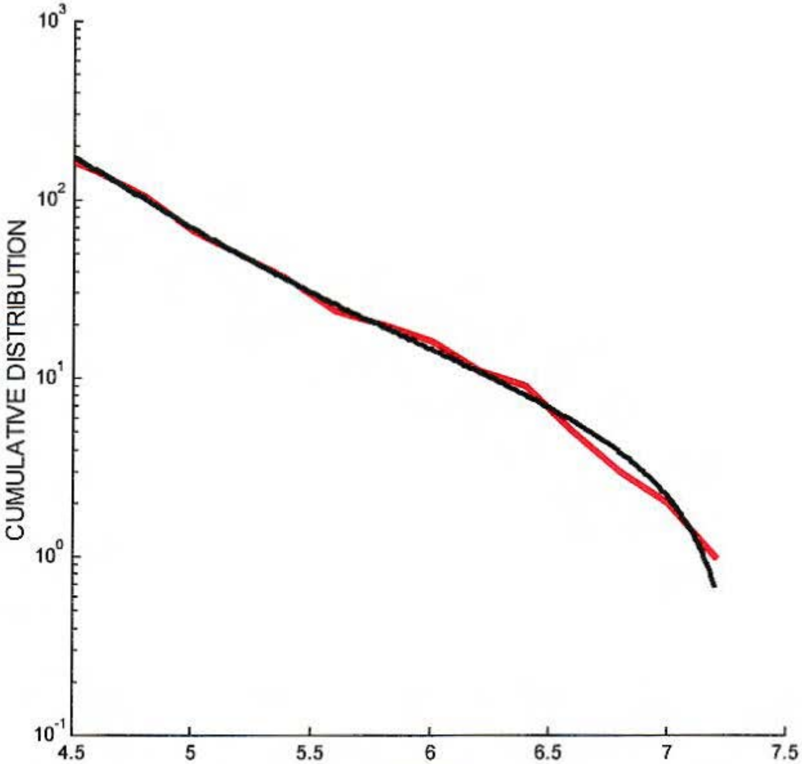

***Figure* 7.3** – A cumulative distribution of earthquakes within the study area. The red curve is an empirical distribution derived from the parametric earthquake catalogue listed in Table 5.1; and the black curve is obtained by fitting Eq.(7.4) to the data. The parameters obtained are $a_1 = 15.1431$, $b_1 = 2.079$, $a_2 = 2.1301$, $b_2 = 0.047305$, $\max(M_S) = M_{max} = 7.2976$.

It should be noted that the total number of earthquakes equals the area under the density function, Eq. (7.3), that is:

$$\begin{aligned} N_{total} &= \frac{\alpha_1}{\beta_1}\left(\exp(-\beta_1 M_{1,min}) - \exp(-\beta_1 M_{1,max})\right) \\ &\quad + \frac{\alpha_2}{\beta_2}\left(\exp(-\beta_2 M_{2,min}) - \exp(-\beta_2 M_{2,max})\right) + \chi_2\,\Delta M \end{aligned} \qquad (7.5)$$

The model fitting is carried out as a constraint, non-linear optimisation problem. This problem is solved by applying a Nelder-Mead type simplex search method, assuming $M_{1,min} = M_{2,min} = M_{min} = 4.5$, and $M_{1,max} = M_{2,max} = M_{max}$ as well as $\Delta M = 0$.

Figure 7.3 displays the fitted distribution, Eq.(7.4), along with the empirical magnitude distribution as derived from the parametric catalogue listed in Table 5.1. The corresponding density function, Eq.(7.3) is plotted in Figure 7.4 along with the empirical data. The fit seems to be reasonable, even though the log-scale distorts the "vision". It should also be clear after visual inspection of Figures 7.3 and 7.4 that the suggested compound distribution fits the data better than a traditional exponential distribution.

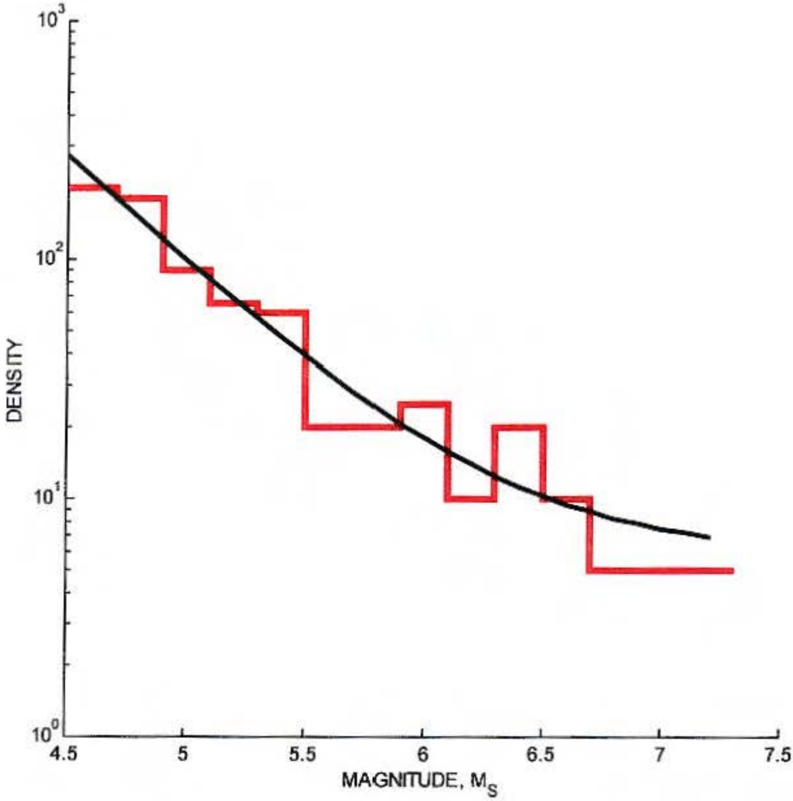

Figure 7.4 – A density distribution of earthquakes within the study area. The red curve is an empirical distribution derived from the parametric earthquake catalogue listed in Table 5.1; and the black curve is obtained by fitting Eq.(7.3) to the data. The parameters obtained are a_1 = 15.1431, b_1 = 2.079, a_2 = 2.1301, b_2 = 0.047305, max(M_S) = M_{max} = 7.2976.

It should be noted that the total number of earthquakes equals the area under the density function, Eq. (7.3), that is:

$$\begin{aligned} N_{total} = {} & \frac{\alpha_1}{\beta_1}\left(\exp(-\beta_1 M_{1,min}) - \exp(-\beta_1 M_{1,max})\right) \\ & + \frac{\alpha_2}{\beta_2}\left(\exp(-\beta_2 M_{2,min}) - \exp(-\beta_2 M_{2,max})\right) + \chi_2\,\Delta M \end{aligned} \tag{7.5}$$

The model fitting is carried out as a constraint, non-linear optimisation problem. This problem is solved by applying a Nelder-Mead type simplex search method, assuming $M_{1,min} = M_{2,min} = M_{min} = 4.5$, and $M_{1,max} = M_{2,max} = M_{max}$ as well as $\Delta M = 0$.

Figure 7.3 displays the fitted distribution, Eq.(7.4), along with the empirical magnitude distribution as derived from the parametric catalogue listed in Table 5.1. The corresponding density function, Eq.(7.3) is plotted in Figure 7.4 along with the empirical data. The fit seems to be reasonable, even though the log-scale distorts the "vision". It should also be clear after visual inspection of Figures 7.3 and 7.4 that the suggested compound distribution fits the data better than a traditional exponential distribution.

Relation of surface wave magnitude and seismic moment – As pointed out earlier, seismic moment, M_o, is a better measure of the size of an earthquake than the surface wave magnitude, M_S. The seismic moment is generally only obtainable for the larger events of the last twenty years or so, while the surface wave magnitude is available for a much longer period. Table 5.2 lists the events from 1977 within our study area, for which we have obtained both seismic moment and surface wave magnitude. For the study area, on the other hand, we have derived surface wave magnitudes for events since 1896. It therefore is desirable to have relations linking the seismic moment to the surface wave magnitude. Such relations are discussed in Chapter 4 (pages 24 to 26).

Kanamori [1977] defines the seismic energy magnitude as given in Eq.(4.14), that is:

$$M_W = \tfrac{2}{3}\log_{10}(M_o) - 10.73 \tag{4.14}$$

It is commonly assumed that $M_S = M_W = \mathbf{M}$ holds for shallow events when the entire thickness of the seismogenic zone ruptures. For the general case, Ekstom and Dziewonski [1988] put forward a 'compound' relation based on available global data (see Eqs.(4.16) and (4.17) on page 25 and 26). Furthermore, Ambraseys [199?] has derived the following relation based on ...

$$M_S = -48.443 + 3.487\log_{10}(M_o) - 0.0527(\log_{10}(M_o))^2 \tag{7.6}$$

For our study, we suggest the same form of expression for relating M_S and M_o, that is:

$$M_S = c_1 + c_2\log_{10}(M_o) + c_3(\log_{10}(M_o))^2 \tag{7.7}$$

We have fitted this expression to the data listed in Table 5.2, using constrained optimisation, applying Eq.(4.14) as an asymptote. The resulting coefficients are:

$$[c_1, c_2, c_3] = [-33.6097,\ \ 2.3649,\ \ -0.031489]$$

The applicability of Eq.(7.7) to the above-listed coefficients is restricted to events in our study area with magnitudes greater than 4.

In Figure 7.5, the above-mentioned curves are plotted along with the data from Table 5.2. We see that all the data points are positioned above the Ekstom-Dziewonski-relation (the green curve). This implies that we would underestimate the surface wave magnitude for events in our study area by using Eq.(4.16) for a given seismic moment. We also see that the data points do not exceed the Kanamori-relation (the black curve). Furthermore, we see that the data are located in between the Kanamori-curve and Eq.(7.6) (the blue curve). The regression curve, Eq.(7.7) (the red curve), goes through the data points and smoothly approaches the Kanamori-equation. It should be stressed that the above-reported coefficients depend on the weight that is put on this asymptotic behaviour in the regression analysis. Finally, it is worth noting that the 'constant' in Eq.(4.14) equals 10.73, while the corresponding parameter in the Ekstrom-Dziewonski-formulas (see Eq.(4.16c)) is 10.76. This results in a barely visually noticeable numerical difference in the asymptotic behaviour of the curves displayed in Figure 7.5.

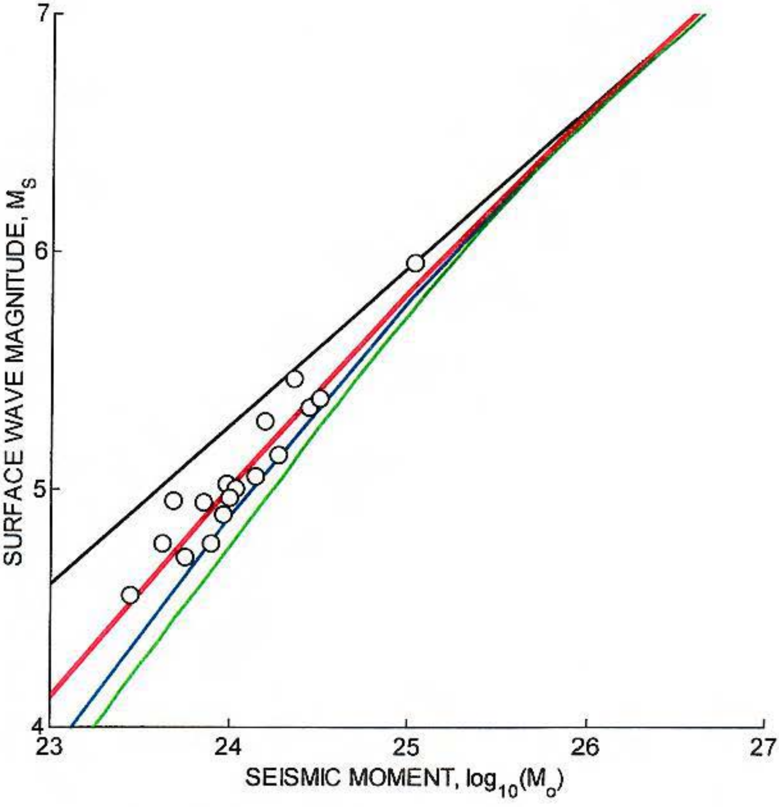

Figure 7.5 – Surface wave magnitude related to seismic moment. The dots denote the data given in Table 5.2 (page 37); the black line is the relation put forward by Kanamori [1977], Eq.(4.14); the green line represents the relations given by Ekstom and Dziewonski [1988], Eq.(4.17); the blue curve is the relation derived by Ambraseys [1997], Eq.(7.6); and the red curve is obtained by fitting Eq. (7.7) to the data given in Table 5.2. The parameters obtained are $c_1 = -33.6097$, $c_2 = 2.3649$ and $c_3 = -0.031489$.

8. FINAL REMARKS

The re-appraisal of the seismicity of Iceland shows that although the historical record is incomplete, careful reading of the available data can provide valuable insights into the long-term seismicity of the region. The main objectives of historical research into primary sources are to refine and extend the information contained in secondary studies and catalogues, and to provide an objective measure of the reliability and completeness of the data retrieved. Historiographical analyses that do not contribute to the conversion of this information into "numbers" are secondary to the concerns of the earth scientist and earthquake engineer.

It is important to establish unambiguously the simultaneity of damage to different localities in an old earthquake. One often finds cases in which two separate events have been transformed into a large earthquake. This is understandable in view of the tendency of both contemporary and later writers to amalgamate seismic events, whether for lack of sufficiently precise information, from ignorance of the true nature of earthquakes, or for simple convenience. Such an amalgamation of effects will over-estimate the size of the damage area and, hence, of the event.

The size of an earthquake can be assessed in terms of its magnitude. Such an assessment for events of the early or pre-instrumental period can be made only approximately and depends on the reliability of information regarding their effects at large epicentral distances or from the dimensions of their epicentral area. For events in which this information could be estimated, the magnitude of the event should be estimated using a calibration formula derived from 20th-century earthquakes for the region.

In estimating intensities, we find that at large distances an earthquake may cause the collapse of a few vulnerable constructions. This information alone should not always be taken to mean that all the other man-made structures at these sites have been destroyed.

For many early events in Iceland, the data are totally insufficient to permit assessment of intensity by any of the Intensity Scales currently in use, let alone to reckon the magnitude of an event, except in very general terms. We find that precise local or epicentral intensities assigned by modern cataloguers to many historical events, in Iceland and elsewhere, are hypothetical.

Earth-scientists and engineers often use earthquake catalogues to assess earthquake hazard. A more critical attitude is needed to rely only on those that combine the interpretation of primary sources with estimates of the reliability and completeness of the data provided.

Some of the methods employed in the modern cataloguing of earthquakes have frequently been inadequate. This has often been due to the interdisciplinary nature of this field of study, which requires scientists to examine literary texts and historians to glean scientific information from their sources. The result of this incoherence of method used by some seismophile historians has been the production of false earthquakes, or of seismic events of a size beyond the limits of the possible, often with a sensationalist tinge. This is of no technical consequence, provided that the earth-scientist and engineer are aware of it.

In view of the large number of errors in recent catalogues, it is important that principles of interpretation should be laid down for the benefit of those working in historical seismicity, since this kind of work will be of value to engineers and other scientists only when the results are reasonably reliable and able to be converted into figures.

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Nordri

Visir

Thjódólfur

Thjódviljinn

Timinn

Maps

Geology map of Iceland, 1998

APPENDIX A

Surface wave magnitude re-evaluation of earthquakes within 62°-68° N and 12°-26° W

PART I - BAAS PERIOD: 1896 - 1918

A key to the worksheets is given on page 123.

```
Date          Time     Epicentre     Ms

1896 Aug 26 2320-- 63.97-20.20m                                    @
Station        D     Az     t      T     2A    V     To   Mab    Mam
PAV Pavia   24.9   125   2322-- 12*   2.0   20     6          6.24
PAD Padova  25.7   121   2330--              80     2
QCI Rome    29.0   124   2323-- 10    2.3   12     8   6.80 6.71
RDP Rocca   29.5   124   2326-- 14    3.0   14     8   6.88 6.62
                                14    0.5   10     5   6.60 5.90
CSM Ischia  30.4   123   233009 18    2.6    8    13   6.75 6.72
                          II    18    8.0    8    12   7.24 7.21
                         III    18    2.5    8    16        6.70
NIK Nikol   32.8    96   2322   15*  20.0  150         6.31 6.46
CAT Catan   33.8   124   232504 15*   5.5   13    10   7.33 6.99
                                              mean M   6.84 6.62
                                               std M   0.35 0.39
                                                   n   7    9

1896 Aug 27 1047--  64.13-20.25m                                   @
Station        D     Az     t      T     2A    V     To   Mab    Mam
QCI Roma    29.5   124   110000  -     -      -     -
CSM Ischia  30.4   123   105505 18    0.6    8    13   6.11 5.99
                           II   18    1.6    8    12   6.50 6.42
                           III  18    0.2    8    16   5.64 5.51
NIK Nikol   32.8    96   1052-- 15*   9.0  150         5.96 6.03
CAT Catan   33.8   124   105205 15*   3.0   13    10   7.07 6.63
                                              mean M   6.26 6.12
                                               std M   0.55 0.43
                                                   n   5    5

1896 Sep  5 2357--    63.98-20.70m                                 @
Station        D     Az     t      T     2A    V     To   Mab    Mam
PAV Pavia   24.9   125    2404-- 12* 2.0   20     6           6.15
PAD Padova  25.7   121    2400--              -
QCI Rome    29.0   124   240225   12  2.2   12     8   6.78 6.52
RDP Rocca   29.5   124            14  1.0   14     5   6.40 6.06
```

CSM	Ischia	30.4	123	11	0.9	8	12	6.29	6.38
NIK	Nikol	32.8	96	15*	14.0	150		6.16	6.22
CAT	Catan	33.8	124	9	2.5	13	10	6.99	6.77
							mean M	6.52	6.35
							std M	0.34	0.26
							n	5	6

1899 Jan 31 1112-- 66.30-19.90m @

St	*D*	*Az*	*T*	*A*	*V*	*Mam*	*Mab*	*Ms*
NIK	33.1	100	15*	4	150		6.08	5.77
	Milne instruments							
SHI	18.4	140		1		5.94		
KEW	18.0	137		0.60		5.71		
TOR	39.0	264		0.20		5.65		
VIC	51.2	304		0.10		5.50		
					=>	5.70(0.18)4		

1899 Feb 23 1336-- 63.50-23.50m @

St	*D*	*Az*	*T*	*A*	*V*	*Mam*	*Mab*	*Ms*
	Milne instruments							
SHI	16.9	130		0.75		5.77		
KEW	16.9	126		0.45		5.55		
TOR	37.6	226		0.50		6.03		
VIC	52.3	305		0.10		5.51		
					=>	5.71(0.24)4		

1899 Feb 26 1336-- 63.50-23.50m @

St	*D*	*Az*	*T*	*A*	*V*	*Mam*	*Mab*	*Ms*
	Milne instruments							
SHI	16.9	130		1.0		5.90		
KEW	-							
VIC	52.3	305		0.1		5.51		
TRI					=>	5.70(0.28)2		

1899 Feb 27 1117-- 63.95-22.80m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
NIK	33.6	93	15*	3.5			5.77	6.03
		Milne instruments						
SHI	16.9	130		2		6.20		
KEW	16.6	126		0.85		5.82		
TOR	37.6	266		1		6.33		
					=>	6.12(0.26)3		

1899 Feb 27 1521-- 63.80-22.80m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
TRI	33.1	118	15*	2			5.95	

Milne instruments

SHI	16.9	130	1	5.90
VIC	52.3	305	0.1	5.51

=> 5.71(0.28)2

1904 Aug 2 1012-- 66.30-18.70 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	18.5	128	12	17	-	-	5.65	5.77
POT	21.0	116	21	11	20	20	5.54	5.64
			15	9	16	10	5.43	5.53
			20	10	16	6	5.31	5.41

=> 5.48(0.15)4 => 5.59(0.15)

Milne instruments

SHI	1150	18	0.2	5.23
EDI	1002	13	0.2	5.05

=> 5.14(0.13)2

1905 Nov 15 0650-- 66.20-18.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
GTT	20	122	12	1	12	2	4.84	4.95
POT	21	116	14	20	-	-	5.73	5.83
STR	22	130	7	7	9	6#	5.59	5.69

=> 5.39(0.48)3 => 5.49(0.47)

Milne instruments

BID	15	142	0.5	5.52	
PAI	12	141	0.5	5.41	
TOR	40	269	0.1	5.36	
VIC	52	306	0.05	5.21	=> 5.36(0.13)4

1905 Nov 19 2335-- 64.00-20.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
STR	23	127	8	1.8mm	11	1.5mm		
GTT	21	119	3	1PH				
POT	21	114	13#	12/2			5.26	
UCL	20	129		3.8mm				

=> 5.26(-)1 => 5.36

Milne instruments

EDI	13	133	0.2	5.05	
TOR	40	269	0.05	5.06	
VIC	52	306	0.05	5.21	=> 5.11(0.09)3

1906 Mar 19 0757-- 68.70-17.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
GTT	21	129	3	8	3	2.3PH			6.64
			14	35	14	4.5PH			6.60
			11	30	15	45SH			6.62
			19	100	19	50	6.28	6.38	
POT	22	124	16	210	22	125	6.62	6.72	

			24	220	13	110	6.65	6.75	
LEI	22	126	3	17	3	6PH			7.28
			15	22	15	11SH			6.40
			12	11(0)	12	5(0)	6.53	6.63	
OSA	75	23	14	25	-	-	6.66	6.63	

=> 6.55(0.16)5 => 6.62(0.15)

Milne instruments

SHI	23	167	1.5	6.25
KEW	23	147	1.5	6.23
EDI	18	169	2.5	6.33
PAI	18	172	2.6	6.35
SFR	37	176	0.75	6.20
AZR	37	202	1.2	6.40
TOR	43	267	0.6	6.18
BEY	46	125	1.0	6.43
IRK	46	51	1.2	6.52
VIC	50	308	1.1	6.53
CAL	70	76	1.0	6.67
BAT	103	67	0.3	6.35

=> 6.37(0.15)12

1906 Nov 9 0220-- 66.20-18.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
UPP	17	95	-	-	13	0.9	4.29	4.41	
GTT	20	123	-	-	12	0.8	4.39	4.50	
POT	21	118	20	8/2	22	3/2	4.80	4.90	
LEI	21	119	-	-	15	2.5	4.83	4.93	

=> 4.58(0.28)4 => 4.68(0.27)

1908 Dec 26 0704-- 66.20-18.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
SHI	18	143	-	-	-	0.1	4.92	5.04	
POT	21	117	10#	2	10#	2	4.93	5.03	

=> 4.92(0.01)2 => 5.03(0.01)

1910 Jan 22 084830 66.50-17.50r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
UPP	17	100	10	9	10	9P			6.10
			10	26	-	-S			7.31
			-	-	12	250	6.75	6.67	
HAM	18	121	8	75	8	55SH			7.27
			20	1000	10	800	7.33	7.50	
DBN	19	134	5	55	5	25P			7.18
			12	1360	-	-	7.58	7.69	
UCL	20	137	-	-	8	220	7.00	7.11	
GTT	21	127	15	50	15	50P			6.87
			4	120z	-	-			7.58
			22	250	22	275S			7.23
			18	900	18	400	7.23	7.33	
LEI	22	124	4	15	4	10P			6.95
			9	60	8	28S			7.09

```
                10  250    12  200    6.99  7.09
STR   23 134     5   20     -    -P               7.10
                20 1000     -    -    7.36  7.45
HOH   23 132    16 1160     -    -    7.52  7.61
VIE   26 122     9   69     9  117S               7.38
                14  467    14  415    7.30  7.38
LVV   27 110    13  10(0)   -    -    6.66  6.74
CRT   30 158    10  160     -    -    6.98  7.04
                14  460     -    -    7.38  7.44
OSA   76  23    22   50     -    -    6.88  6.85
DJA  108  61    15   14    15   15    6.82  6.75
                                 => 7.13(0.29)14 =>  7.19(0.32)
```

Milne instruments

```
EDI   13  144  29   7.23
ESK   14  145  20+  7.09
STO   15  146  29   7.31
BRO   17  147  76+  7.77
SHI   18  147  30+  7.42
KEW   18  145  17+  7.16
GUI   18  145  29   7.40
SFR   32  163  16   7.44
MLT   36  134   6   7.09
TOR   40  266  20   7.66
BALT  43  260   5   7.10
BEY   45  111 2.2   6.77
HLW   47  118 1.0   6.45
VIC   52  306   5   7.20
BOM   72   83  0.8  6.59
CAL   75   67  3.3  7.22
TOK   75   19  0.5  6.41
KOD   82   82   1   6.75
COL   86   81  0.9  6.73
HON   87  324   3   7.26
MAU  103  111  0.5  6.58
CAP  105  150   2   7.19
ADL  145   36 0.15  6.24    => 7.08+(0.39)21
```

1912 May 06   1859-- 63.98-19.83m @

```
 St    D    Az T1    A1    T2    A2     Ms    Msc    mB
UPP   18    86  5    16     5   23P                 6.75
               10   101    10    7S                 7.21
               12   250+   12  135    6.76  6.88
DBN   18   120  6    35     6    6P                 6.77
                6    60     6   65S                 7.37
               15 1580     16 1680    7.56  7.68
UCL   18   124  -     -    13  280    6.83  6.95
HAM   18   110 11   640     -    -    7.27  7.39
POT   21   109  4    32     4   36P                 7.28
                6    25     6   45S                 6.93
               12   350    12  210    7.03  7.13
STR   21   123  -     -    12  430    7.15  7.25
HOH   22   120 12   780     -    -    7.44  7.54
```

VIE	25	111	-	-	14	440	7.22	7.30	
GRA	26	114	7	7	5	5PH			6.76
			-	-	12	23SH			6.58
			-	-	16	290	7.00	7.08	
LVV	27	100	14	60	-	-	6.41	6.49	
CRT	29	152	20	680	-	-	7.25	7.32	
OTT	35	266	12	135	12	55	6.96	7.01	
BRK	62	299	-	-	13	130	7.27	7.26	
LIK	62	298	-	-	18	39	6.71	6.70	
OSA	79	20	19	30	-	-	6.75	6.71	
ZKW	80	33	18	72	20	59	7.15	7.11	
DJA	111	59	20	19	20	17	6.80	6.73	
RIV	149	15	18	6	-	-	6.53	6.42	

=> 7.01(0.31)18 => 7.05(0.35)

Milne instruments

ESK	12	128	13.8	6.85	
EDI	12	126	15+	6.87	
CRK	13	148	18.0	7.03	
BID	14	133	3.2	6.29	
STO	14	130	29.8	7.25	
BRO	15	132	88.0	7.77	
KEW	16	131	7.4	6.74	
GUI	16	132	37.6	7.45	
HAS	16	133	10.5	6.90	
SHI	17	135	10.5	6.91	
AZO	26	190	21.4	7.47	
RTN	27	157	12.0	7.24	
SFR	29	157	18.0	7.44	
MLT	35	127	3.0	6.77	
TOR	39	267	8.5	7.27	
BEY	45	105	7.8	7.32	
HLW	47	112	3.1	6.94	
STV	48	185	6.2	7.25	
VIC	53	306	6.8	7.35	
NOR	66	193	1.2	6.73	
BOM	74	79	1.9	6.98	
CAL	77	64	5.0	7.42	
KOD	84	79	2.7	7.20	
COL	88	78	1.1	6.83	
HON	89	322	1.0	6.80	
CAP	103	148	1.0	6.87	
MAU	103	110	0.5	6.58	
ADL	148	34	0.6	6.85	=> 7.05(0.33)27

1913 May 19 1545-- 66.30-18.80r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
UPP	18	82	5	1.7	5	4S			6.14
HAM	18	117	16	16	20	14	5.47	5.59	
STR	22	128	6	15SH					6.60
			6	10			5.83	5.93	
GRA	26	119	7	3	7	2	5.35	5.43	
BAK	45	89	20	9	19	8	5.83	5.85	

```
IRK  57   37 19    2   20     2  5.38  5.38
                              => 5.57(0.24)5 => 5.63(0.25)
```

Milne instruments

```
SFR  28  154  0.5  5.87
PAI  11  123  0.5  5.36
ESK  12  122  0.3  5.18
EDI  11  120  0.1  4.68
BRO  14  128  3.2  6.32
SHI  16  130  0.6  5.65
HAS  16  128  0.2  5.17
GUI  16  128  3.5  6.41  => 5.58(0.60)8
```

1913 Jul 26 2051-- 67.00-18.00 @

```
 St  D   Az  T1   A1   T2   A2    Ms    Msc   mB
UCL  13  119 15   18   16   22    5.43  5.58
UPP  17   98  6   1S   -    -                 6.02
             15    6   -    -     5.06  5.18
HAM  19  121 12   27   -    -     5.88  5.99
HOH          10   2(0)
POT  21  119 16   25   16   20    5.81  5.91
STR  23  132  9   18    9    8    5.89  5.98
VIE  26  117 13   12   13   16    5.84  5.92
GRA  26      14    8   15   11    5.63  5.71
BUD  27  117 11    2   -    -     5.04  5.12
IRK  53   40  -    -   16    6    5.83  5.83
                              => 5.60(0.34)9 =>  5.69(0.33)
```

Milne instruments

```
ESK  14  142  0.7  5.64
EDI  14  141  0.6  5.56
BID  16  145  0.3  5.34
STO  16  143  1.2  5.93
CRK  16  158  1.0  5.88
BRO  17  144  4.0  6.50
HSL  17  143  1.5  6.12
GUI  18  143  4.2  6.57
KEW  18  142  0.4  5.54
RTN  30  161  0.7  6.06
AZO  30  191  2.6  6.62
SFN  32  161  0.7  6.08   => 5.99(0.44)11
```

1914 Jun 19 0006-- 63.50-24.00r @

```
 St  D   Az  T1   A1   T2   A2    Ms    Msc   mB
DBN  20 108  13   5    14   9     5.36  5.47
UPP  21  79  12   1    -    -     4.52  4.62
HAM  22       8   2     9   1     4.95  5.05
GTT  23      12   1    12   2     4.83  4.92
STR  24 111 4.5  0.8  4.5  0.5PH              5.82
             12   5    12   3     5.25  5.34
```

POT	24	99	14	3	14	4	5.13	5.22	
VIE	28	102	13	3	13	4	5.29	5.36	

=> 5.05(0.30)7 => 5.14(0.3)

1917 Jul 9 002200 62.70-26.40 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	*mB*
UPP	18	86	15	28	15	12	5.69	5.81	
DBN	18	121	15	33	16	28	5.82	5.94	
VIE	25	111	-	-	18	12	5.55	5.63	
HOH			12	8	18	9			

=> 5.69(0.13)3 => 5.79(0.16)

NOTES

A key to the worksheets in Part I

Undamped and Milne recordes

D	Geocentric epicentral distance in degrees
Az	Station azimuth
t	Origin time (GMT)
2A	Maximum double trace amplitude of surface waves in mm
T	Period of 2A
V	instrument gain
To	natural period of instrument
Mab	equivallent Ms from Milne readings from Abe (1994),
Mam	equivallent Ms from Ambraseys & Melville (1982)
*T	values assessed from distance D (Karnik)

Damped instruments

St	Station code
D	Geocentric epicentral distance of station in degrees
Az	Azimuth of station
A1 A2	Maximum horizontal ground displacements of long phases
T1 T2	Corresponding periods in seconds
z	Indicates A and T readings taken from vertical component
PH/SH	Amplitude and period readings from PH/SH phases recorded by medium period instruments for mB determinations
Ms	Event magnitude from Prague formula
Msc	Event magnitude corrected for distance

(Event M)(Standard deviation)(number of stations reporting)
=>Ms (Prague) => Msc (Prague, corrected for D)

Sources used for epicentral locations for Period I:

Abe, K. [1981],
Abe, K. [1994],
Ambraseys, N. and Melville, C. [1982],
Ambraseys, N. and Free, M. [1997],
Seismological Investigations, British Association for the Advancement of Science, pp.28-36, 1911, & pp.3-20, 1912 - 1918,
Gutenberg, B. and Richter, C. [1965],
Karnik, V. [1968],
Linden, N. A. [1959],
Tams, E. [1919], [1927].

PART II - ISS PERIOD: 1918 – 1966

A key to the worksheets is given on page 137.

```
1919 Feb 15  021717  68.20-13.00                                  @
 St  D  Az   T1    A1    T2  A2      Ms    Msc
UPP  15 107  20    5.0   17  6.6    4.93  5.07
DBN  18 142              13   10    5.38  5.50
                                 => 5.16(0.32)2 => 5.28(0.30)

1920 May 14  175730  64.00-22.00                                  @
 St  D  Az   T1    A1    T2    A2    Ms    Msc
DBN  18 117  14     9    13    11    5.42  5.54
UPP  19  84  12    1.5               4.61  4.72
HAM  19 108              10     2    4.84  4.98
VIE  26 109              10     4    5.35  5.43
                                 => 5.06(0.40)4 => 5.16(0.39)

1920 Jun 25  182218  64.50-23.40                                  @
 St  D  Az   T1    A1    T2    A2    Ms    Msc
DBN  20 108              15     3    4.86  4.97
                                 => 4.86( - )1 => 4.97

1921 Aug 23  201716  67.00-18.00                                  @
 St  D    Az    T1  A1    T2    A2    Ms    Msc
UPP  17    97   14  26    12    25    5.79  5.91
DBN  19   131             18   268    6.70  6.81
HAM  19   121   11  87    14    91    6.43  6.54
UCL  20   134             18   112    6.35  6.46
POT  21   119   16  65                6.20  6.30
PAR  21   140    10  11   13    30SH              6.44
                 13  74   10    66    6.43  6.53
STR  23   132    16 104   16   166    6.64  6.73
VIE  26   120             10     9S               6.25
                          20    59    6.22  6.30
FBR  27   153             16   200    6.87  6.95
LVV  27   108             10    35    6.32  6.40
POL  28   127             13    12    5.77  5.84
ALG  33   148    22  15   22    80    6.38  6.43
BRK  61   299             11   0.4   (4.92)
LPZ  92   227    15   3               5.95  5.90
                                 => 6.31(0.33)13 => 6.39(0.35)

1923 Oct 20  002401  65.00-16.50                                  @
 St  D  Az   T1    A1    T2    A2    Ms    Msc
DBN  17  132             11     5    5.08  5.20
```

PAR	19		12	2	12	1	4.68	4.79

=> 4.88(0.28)2 => 4.99(0.29)

1924 Sep 04 160101 63.90-22.05m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	
UPP	19	83	10	1			4.53	4.64	
UCL	19	119	23	4			4.78	4.89	
DBN	19	116			12	14	5.58	5.69	
PAR	20	126	5	3	5	3SH			5.73
			8	4	10	4	5.27	5.38	
HAM	20	107	10	3	10	4	5.14	5.25	
POT	22	105			4	2S			6.00
					13	5	5.20	5.30	
VIE	27	105			10	5	5.38	5.46	
ALG	31	138	14	2			5.03	5.09	
VIC	52	304	10	1	15	4	5.67	5.68	

=> 5.18(0.36)9 => 5.26(0.35)

1924 Dec 12 022045 63.80-22.80m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	116			18	9	5.21	5.32
HAM	20		12	5z			5.06	5.17

=> 5.13(0.10)2 => 5.24(0.11)

1927 Apr 29 111940 66.30-19.50 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	128			14	4	4.96	

=> 4.96 => 5.07

1927 Jul 31 205900 66.50-19.00r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	17	131			11	1.5	4.58	4.70
HAM	19	116	15	2			4.63	4.74
PAR	20	135			12	2	4.79	4.90
TAS	52	71	10	0.4			4.86	4.87

=> 4.71(0.13)4 => 4.80(0.10)

1928 Aug 1 190330 62.70-25.00r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
EBR	26	138	18	2			4.78	

=> 4.78 => 4.86

1928 Aug 1 194620 62.70-25.00r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
SCO	8	00	7	4	8	4	4.66	4.86
COP	19	96	14	1			4.37	4.48

=> 4.52(0.20)2 => 4.67(0.27)

1928 Aug 1 202806 62.70-25.00r @

St	D	Az	T1	A1	T2	A2	Ms	Msc
SCO	8	00	7	4	7	5	4.72	4.92
COP	19	96	15	1			4.35	4.46

=> 4.54(0.26)2 => 4.69(0.32)

1928 Aug 1 204549 62.70-25.00r @

St	D	Az	T1	A1	T2	A2	Ms	Msc
SCO	8	00	7	4	8	4	4.66	4.86
COP	19	98	14	1			4.37	4.48

=> 4.52(0.20)2 => 4.67(0.27)

1929 Jan 6 000145 63.70-23.00m @

St	D	Az	T1	A1	T2	A2	Ms	Msc
DBN	19	116	14	6	13	9	5.32	5.43
VIC	52	303			15	2	5.37	5.38

=> 5.34(0.04)2 => 5.41(0.3)

1929 Jul 23 184351 63.90-21.70m @

St	D	Az	T1	A1	T2	A2	Ms	Msc
KEW	17	128			13	73	6.18	6.30
DBN	18	118	13	132	16	135	6.51	6.63
UPP	19	84	11	38			6.05	6.16
UCL	19	121	15	68			6.18	6.29
HAM	19	108			11	95	6.46	6.57
PAR	20	128	14	100	14	90	6.44	6.55
POT	21	106	15	84			6.34	6.44
GOT	21	112	7	11	7	3SH		
			11	20	13	65	6.23	6.33
STR	22	120	11	26	10	36	6.16	6.26
LEI	22	109	2	10	2	10PH		
			12	40	12	20	6.09	6.19
KRL	22	118	10	33			6.15	6.25
BAR	25	144	10	50	10	45	6.45	6.53
VIE	26	109	10	24			6.12	6.20
			11	48z			6.29	6.37
EBR	26	140	9	12			5.89	5.97
GRA	29	149	16	62	14	80	6.55	6.62
INT	38	266	15	12	15	12	5.97	6.01
VIC	52	305	20	49			6.64	6.65
BOM	75	77	19	10			6.23	6.20
ZKW	81	31	20	18z			6.52	6.48
LPZ	88	224			19	2	5.65	5.60

=> 6.24(0.24)21 => 6.31(0.26)

1929 Jul 23 200410 63.90-21.70m @

St	D	Az	T1	A1	T2	A2	Ms	Msc
DBN	18	118			13	8	5.27	5.39
HAM	19	108	8	10	10	2	5.48	5.59

PAR	20	128	13	3	11	2	4.95	5.06

=> 5.23(0.27)3 => 5.35(0.27)

1930 Aug 25 1535-- 63.90-22.20m **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	117	13	1.5	13	1.5	4.62	4.73

=> 4.62 => 4.73

1933 Jun 10 120654 63.90-22.20m **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KEW	17	127	12	17			5.59	5.71
DBN	18	118			14	29	5.82	5.94
UPP	19	84	10	5	13	4	5.16	5.27
PAR	20	127	9	18	10	12	5.82	5.93
GTT	21	111	13	5	13	4	5.18	5.28
STR	22	119			7	11	5.83	5.93
LEI	22	108		8		3SH		
			10	5	10	2	5.26	5.36
STU	23	117	15	11	15	8	5.51	5.60
			15	15z			5.56	5.65
CHE	23	111	12	11	12	20	5.84	5.93
VIE	26	109	9	4	11	10	5.68	5.76
BUD	28	106	13	5	13	4	5.39	5.46
VIC	52	304			15	11	6.11	6.12

=> 5.60(0.29)13 => 5.69(0.28)

1933 Jun 10 163009 63.90-22.20m **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	18				13	2	4.69	4.81

1933 Oct 5 054954 68.50-19.50 **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	20	132	14	2.5	11	3	4.96	5.07
PAR	22	140	9	2	10	1	4.92	5.02

=> 4.94(0.03)2 => 5.05(0.04)

1933 Oct 5 062140 68.50-19.50 **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	20	132	14	6	12	6	5.27	5.38
PAR	22	140	9	2	10	2	5.02	5.12
KUC	28	87	20	2			4.81	4.88

=> 5.03(0.23)3 => 5.13(0.25)

1934 Jun 02 134240 65.97-18.48m **@**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KEW	17	139	16	76			6.12	6.24
UPP	17	94	17	42			5.84	5.96
DBN	18	128			15	104	6.32	6.44

UCL	19	132	14	28			5.82	5.93	
GTT	20	122	22	50	22	75	6.07	6.18	
PAR	20	138	13	52	13	51	6.22	6.33	
JEN	21	120	12	8	15	30	5.86	6.96	
LEI	21	118	4	8	4	2P			6.51
					12	14S			6.07
			16	40	18	55	6.10	6.20	
POT	21	116	14	40	14	50	6.16	6.26	
STU	22	127	15	36	15	25	6.01	6.11	
STR	22	129	15	48			6.14	6.24	
PUL	22	83	16	35	17	24	5.95	6.05	
CHE	22	120	24	100	24	60	6.23	6.33	
VIE	25	117	14	30			6.05	6.13	
BUD	27	115	9	4		S			6.05
			19	37	19	26	6.05	6.13	
LJU	27	123			12	35	6.24	6.32	
FBR	27	145			11	40	6.34	6.42	
MUC	28	83	17	33	16	33	6.16	6.23	
GRA	30	156	14	23	12	19	6.11	6.17	
BEO	30	116			13	21	6.06	6.12	
TAS	52	72			13	12	6.21	6.22	
VIC	52	306			22	11	5.95	5.96	
VLA	68	23	13	1z			5.33	5.31	
BOM	73	81	24	8	18	5	6.05	6.02	
LPZ	90	227	18	4			5.99	5.94	

=> 6.06(0.20)26 => 6.17(0.28)

1934 Jun 3 203440 65.97-18.48r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	18	128			20	2	4.49	4.61
CHE	22	120			18	5	5.08	5.18

=> 4.78(0.42)2 => 4.89(0.40)

1935 Oct 9 220845 64.00-21.50m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KEW	17	128	13	21z			5.54	5.66
DBN	19	114	18	87	17	25	6.14	6.25
UPP	20	83	12	7	12	8	5.38	5.49
PAR	20	128	10	17	8	18	5.90	6.01
JEN	21	111	2	1PH				
			6	2	8	3SH		
			16	5	14	8	5.29	5.39
					12	10	5.52	5.62
GTT	21	112	4	1.4	4	0.6PH		
					9	2.1S		
			10	3.6	10	4.1	5.22	5.32
LEI	22	110	12	3	12	6SH		
			12	8	12	5	5.41	5.51
POT	22	104	13	10	13	10	5.57	5.67
CHE	23	112	12	4	12	4	5.23	5.32
PRA	24	109	10	5	11	14	5.73	5.82

PUL	24	76	20	10	20	12	5.49	5.58
VIE	27	107	10	11	11	10	5.82	5.90
SFR	29	154	11	7	12	16	5.91	5.98
GRA	29	149			3	8!	6.25	6.32
MOS	30	78	13	11	12	14	5.90	5.96
SVE	38	61	15	9	15	15	5.99	6.03
			15	18			6.10	6.14
TAS	54	68			15	4	5.70	5.70
			15	7z			5.84	5.84

=> 5.70(0.31)20 => 5.76(0.30)

1936 Oct 22 234928 66.80-17.40m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	18	132	10	26	12	10	5.80	5.92
KEW	18	143	14	7	12	10	5.55	5.67
JEN	21	123	1.2	0.2PH				
			8	1			4.59	4.69
PAR	21	141	16	5	16	8	5.25	5.35
STR	22	132	16	11	16	13	5.57	5.67
PUL	22	86	14	3	15	2	4.92	5.02
			15	8z			5.26	5.36
PRA	23	120	9	2	9	1SH		
			14	2	14	2	4.87	4.96
MOS	28	86	13	4	13	4	5.33	5.40
SVE	36	67	16	2	17	2	5.11	5.16

=> 5.22(0.37)10 => 5.32(0.37)10

1936 Oct 23 000020 66.80-17.40m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
UPP	17	97	15	5	14	4	4.99	5.11
KEW	18	142	15	12	12	15	5.52	5.64
DBN	18	132	13	17	10	35	5.91	6.03
GTT	20	125	14	2	11	2	4.81	4.92
			14	8z			5.22	5.33
PAR	21	141	12	3	10	4	5.14	5.24
JEN	21	123	10	1	16	5	5.09	5.19
PUL	22	86	15	4	15	2	5.00	5.10
			15	15			5.53	5.63
PRA	23	120	14	2	14	4	5.07	5.16
MOS	27	86	13	7	13	7	5.57	5.65
SVE	36	67	16	4	17	3	5.35	5.40
			17	5z			5.34	5.39
TBL	42	95			15	4	5.52	5.55
TAS	51	74	13	3	14	3	5.64	5.65

=> 5.31(0.30)15=> 5.40(0.29)

1938 Feb 10 070310 64.60-23.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	117	12	6	14	5	5.20	5.31
CHE	23	111	12	3	12	3	5.12	5.21

TAS	54	68	16#	1			5.08	5.08

=> 5.13(0.06)3 => 5.20(0.12)

1944 Feb 19 113553 63.40-23.80r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ABE	13	124	13	15	15	21	5.41	5.56
UPP	19	90	12	2.4	13	1	4.73	4.84
PRA	24	113	14	5	13	6	5.37	5.46
CHE	24	115	12	1	12	5	5.21	5.30
SVE	38	63	14#	5			5.57	5.61
TAS	53	69	14#	4			5.72	5.72

=> 5.33(0.34)6 => 5.41(0.32)6

1944 Feb 20 193206 63.40-23.80r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ABE	13	124			16	7	4.88	5.03
PRA	24	113			13	2	4.88	4.97
CHE	24	115	12	1	12	4	5.12	5.21

=> 4.96(0.14)3 => 5.07(0.12)3

1944 Feb 21 152631 63.40-23.80r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ABE	13	124			12	9	5.12	5.27
FAR	21	131	9	3			5.13	5.23
PRA	24	113	15	2	13	3	5.01	5.10
CHE	24	115	10	2	10	2	5.03	5.12

=> 5.07(0.06)4 => 5.18(0.08)4

1944 Feb 21 173340 63.40-23.80r @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
PRA	24	113			14	2	4.86	4.95
CHE	24		11	1	11	2	4.89	4.98

=> 4.87(0.02)2 => 4.97(0.02)2

1947 Mar 29 075028 64.00-19.70m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
CHE	22	114			16	2	4.72	4.82
PRA	23	111			11	1	4.61	4.70

=> 4.66(0.08)2 => 4.76(0.08)

1948 Jul 3 154543 64.00-20.50m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ABE	11	119	15	2			4.27	4.44
ALI	29	144	16	(2).8			4.53	4.60

=> 4.40(0.19)2 => 4.52(0.11)

1948 Aug 30 013935 66.50-18.00 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ABE	12	134			11	2	4.45	4.61
STR	22	131	13	2			4.82	4.92
PRA	23	119	12	1	13	1	4.62	4.71

=> 4.63(0.18)3 => 4.75(0.16)

1952 Mar 12 121309 63.90-22.10 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	58	13	2.2	15	3.1	4.80	4.92
UPP	19	84	12	0.7			4.39	4.50
PRA	24	108			12	1	4.61	4.70

=> 4.60(0.21)3 => 4.71(0.21)

1952 May 16 143216 63.90-22.00m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	58	11	0.9	14	1.7	4.55	4.67
ALI	29	142			10	1.3	4.94	5.01

=> 4.75(0.28)2 => 4.84(0.24)

1955 Apr 1 184127 63.97-21.27 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	
KIR	17	59			14	4.4	4.94	5.06	
UPP	18	85	1.5	0.1					4.72Pz
			12	0.9					5.18S
			12	1.6			4.63	4.75	
PRA	23	110	7	1	5	0.6S			5.49S
					14	2	4.83	4.92	

=> 4.80(0.16)3 => 4.91(0.16)

1955 May 19 031119 66.34-17.33 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	
KIR	14	67	1.6	0.3					5.17Pz
			13	0.5	16	1.3	4.21		

=>4.21(-)=> 4.36(-)

1956 Jun 1 104617 63.96-21.88 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	58	12	0.3	15	0.6		4.05

1956 Jun 10 140533 64.40-17.70m @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	16	59	12	0.4	14	1.0	4.21	4.34
UPP	17		16	0.6			4.02	4.14

=> 4.11(0.13)2 => 4.24(0.14)

1956 Oct 29 162100 66.46-17.73 **@**

```
 St  D   Az  T1  A1   T2  A2    Ms    Msc
KIR  15  67  14  1.9  12  1.4          4.49
                                     => 4.49( -  )=>4.63( -  )
```

1956 Oct 30 001104 66.48-17.73 **@**

```
 St    D  Az  T1    A1     T2  A2     Ms    Msc
ABE   12 134  10    2.0               4.48  4.64
DUR   14 139  10    7.0               5.05  5.20
KIR   15  67  1.0   0.2Pz                           5.20
              13    2.2    12  1.8    4.59  4.73

UPP   17  96  17    2.1    14  1.8    4.59  4.71
                               =>  4.68(0.25)4 => 4.82(0.26)
```

1958 Feb 16 230158 67.61-18.84 @

```
 St    D  Az T1   A1   T2   A2     Ms     Msc
KIR   15  71 13  1.4   16   2.7   4.56   4.70
UPP   18  98 15  1.2   21   1.4   4.38   4.50
KEW   19 141 20  1.5   20   2.0   4.50   4.61
                            => 4.48(0.09)3  => 4.60(0.10)3
```

1958 Sep 27 104128 66.07-18.08 **@**

```
 St    D  Az    T1  A1   T2  A2      Ms    Msc
KIR   15  66   13  0.4   12  0.2   3.80
                            =>  3.80( -  ) => 3.94( -  )
```

1959 Jun 28 042329 63.97-19.32 @

```
 St   D  Az    T1    A1   T2  A2       Ms    Msc
KEW  16 133   20   1.5   13  2.0     4.48  4.61
              12   0.5               4.02  4.15
KIR  16  59    6   0.3          SH                5.70
              15   0.5   14  0.7     4.09  4.22
UPP  18  86    6   0.3          SH                4.90
              15   0.7   12  0.2     4.10  4.22
STR  21 124   14   1.0   14  1.0     4.51  4.61
                               => 4.24(0.24)5 => 4.38(0.023)5
```

1959 Dec 8 080820 66.95-18.78 **@**

```
 St   D  Az    T1    A1    T2  A2         Ms    Msc
KIR  15 69   1.0   0.2Pz                             5.2
             14    1.2    16  1.8       4.40
                                 => 4.40( -  )1 => 4.54( -  )
```

1961 May 14 150804 67.70-18.40 @

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	14	71	14	0.6	15	1.1	4.16	4.31
UPP	17	99	15	0.4	20	0.6	3.97	4.09
			16	0.8z			4.04	4.16
KEW	18	142	20	1	20	2	4.45	4.57
PRU	24	121	12	0.5			4.31	4.40

=> 4.19(0.20)5 => 4.31(0.19)

1961 May 14 153807 67.65-18.56 @

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	14	71	15	1.6	15	2.6	4.54	4.69
UPP	17	99	13	1.4	17	1.0	4.40	4.52
			16z	1.5			4.31	4.43
KEW	18	142	20	2.5	20	2.5	4.64	4.76
STR	23	132	15	2.0	15	2.0	4.84	4.93
PRU	24	120	13	0.9			4.53	4.62

=> 4.54(0.19)6 => 4.66(0.18)6

1962 Jun 12 094630 64.90-17.10 @

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	16	62	14	0.3	15	0.5	3.91	4.04
			14z	0.7			4.00	4.13
UPP	18	89	15	0.4			3.90	4.02

=> 3.94(0.06)3 => 4.06(0.06)3

1963 Mar 28 001534 66.37-19.69 @

St	D	Az	T1	A1	T2	A2	Ms	Msc	
DUR	14		14	640			6.88	7.03	
KIR	15	66	10	17	10	44PH			
			11	8.2	7	34SH			
			11	140	13	240	6.64	6.78	
			12	360z			6.73	6.75	
KEW	18	137	8	34					6.63PH
UPP	18	93	10	33	10	37PH			
			22	230	21	230SH			
			17	320	15	240	6.77	6.89	
			16	170			6.41	6.53	
			16	330	16	300	6.82	6.94	
PRU	24	116	6	6.3					6.52PH
			6	6					6.30PV
			13	73					6.95SH
			22	435				6.88	6.97
PRA	24	116	6	6.7					6.55PH
			10	92					7.16SH
			14	330			6.95	7.04	
WAR	24	105	18	472			7.12	7.21	
			12	99z			6.51	6.60	

RAC	25	112	15	125	15	200	6.82	6.90
			10	92z			6.58	6.66
KRA	26	109	12	137	12	87	6.77	6.85
RIV	147	14	26	15z			6.76	6.68

=> 6.78(0.18)14 => 6.85(0.19)14

1963 Apr 27 034234 66.70-19.20 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DUR	15	136	10	1.0			4.33	4.47
KIR	15	68	14	0.3	15	0.9	4.07	4.21
UPP	18	95	13	0.5			4.05	4.17
			18	1.7z			4.23	4.35
STU							4.4	4.49

=> 4.22(0.15)5 => 4.34(0.15)5

1963 Jun 2 160125 67.50-18.70 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	71	15	0.2	15	0.4	3.71	3.85
			14	0.7			3.95	4.09

=> 3.83(0.17)2 => 3.97(0.17)2

1963 Sep 3 091333 62.80-25.20 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	55	14	0.4	16	0.7	4.16	4.27
			14	1.0z			4.28	4.39
UPP	20	79	15	0.4	19	0.4	4.00	4.11
			19	0.6z			3.96	4.07
APA	24	53	18	0.8			4.34	4.43
PRU	26	104	22	0.9			4.33	4.41

=> 4.18(0.17)6 => 4.28(0.16)

1963 Oct 15 095930 67.20-18.40 @

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*	
KIR	15	70	7	4.9PH					
			6	3.7PZ					
			18	12	10	3.0SH			
			14	15	16	30	5.58	5.72	
			14	22z			5.45	5.59	
UPP	17	98	6	1.8	6	1.2PH			
			7	2.4Pz					
			7	2.1	7	1.8SH			
			12	12	19	7.2	5.31	5.43	
			17	9.2z			5.08	5.20	
KEW	18	141			18	32	5.74	5.86	
APA	19	65	14	73	14	8	6.16	6.27	
			14	24z			5.66	5.77	
PRU	24	120	12	14			5.65	5.44	
PRA	24	120	12	18					6.38SH

```
                    10    23                   5.94  6.03
WAR   24   108     12    13     14     18     5.83  5.92
                    12    10z                  5.51  5.60
KRA   26   113     13    11     11      4     5.63  5.71
                                           => 5.63(0.28)12 => 5.71(0.29)
```

NOTES

A key to the worksheets in Part II

St	Station code
D	Geocentric epicentral distance of station in degrees
Az	Azimuth of station
A1 A2	Maximum horizontal ground displacements
T1 T2	Corresponding periods in seconds
z	Indicates A and T taken from vertical component
Ms	Event magnitude from Prague formula
Msc	Event magnitude corrected for distance

(Event M) (Standard deviation) (number of stations reporting)
=>Ms (Prague) => Msc (Prague, corrected for D)

Sources used for epicentral locations and magnitude determination for Period II:

Ambraseys and Free [1997],
BCIS,
Gutenberg and Richter [1965],
ISS,
Karnik [1968],
Linden [1959],
Tams [1927],
USCGS.

PART III - ISC PERIOD: 1964 - 1995

A key to the worksheets is given on page 183.

1964 Jul 11 174432 66.24-19.86 19 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ESK	13	134	20	2.5	20	2.5	4.42	4.57
			20	2.5z			4.25	4.40
KIR	16	66	16	0.7	19	2.0	4.38	4.51
			19	2.8z			4.47	4.60
UPP	18	93	19	1.0	15	0.4	4.18	4.30
			14	0.9z			4.19	4.31
KEW	18	137	20	1.5	20	2.0	4.47	4.59
APA	20	52	14	1.4	12	1.6	4.68	4.79
			16	1.1			4.30	4.41
JEN	22	119	14	0.6	15	0.5	4.26	4.36
MOX	22	119	16	1.7			4.66	4.76
			16	1.5z			4.50	4.60
STU	23	125					4.50	4.58
FRU	24	116	16	1.3			4.59	4.68
FRA	24	116	11	0.8			4.54	4.63

=> 4.43(0.16)15 => 4.54(0.15)

1964 Aug 20 035630 63.89-20.48 21 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ESK	12	127	20	5.5	17	7	4.78	4.94
			23	7.0z			4.57	4.73
KEW	16	130	18	3.5	20	4	4.76	4.89
KIR	17	58	8	0.6	8	1.3SH		
			15	1.9	18	2.1	4.57	4.69
			18	3.1			4.58	4.70
UPP	18	85	20	2.8	21	1.2	4.56	4.68
			19	2.1z			4.43	4.55
JEN	21	112	14	2.5	12	0.7	4.80	4.90
MOX	21	113	14	2.3	14	3.5	4.98	5.08
			14	2.6z			4.76	4.86
APA	22	56	14	2.5	14	2.0	4.88	4.98
			14	2.3			4.74	4.84
STU	22	119					5.0	5.10
FRU	23	110	17	3.8			5.01	5.10
FRA	23	110	11	1.8			4.87	4.96

=> 4.75(0.18)15 => 4.87(0.17)

1965 May 29 225613 63.15-24.60 33 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	56	15	0.4	16	0.4	3.98	4.09
			16	0.8z			4.12	4.23

=> 4.05(0.10)2 => 4.16(0.09)

1966 Mar 26 122957 63.09-24.38 32 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	19	56	12	0.5	12	0.7	4.26	4.37
			11	0.6z			4.16	4.27

=> 4.21(0.07)2 => 4.32(0.07)

1966 Apr 08 231713 67.80-19.20 33 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	15	71	15	0.6	15	0.9	4.10	4.24
			14	1.0z			4.11	4.25

=> 4.11(0.00)2 => 4.21(0.00)

1967 May 16 161122 63.59-18.90 4 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	16	58	15	0.3	15	0.3	3.77	3.90
UPP	17	86	16	0.8			4.16	4.28
			15	0.5z			3.82	3.94
MOX	21	114	15	0.5			4.11	4.21
			15	0.4z			3.92	4.02
PRU	22	112	14	0.4			4.10	4.20

=> 3.98(0.16)6 => 4.09(0.16)

1967 Jun 7 025750 63.56-19.25 26 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
MOX	21	114	15	0.4			4.01	4.11
			15	0.3z			3.80	3.90

=> 3.90(0.15)2 => 4.00(0.15)

1967 Jul 27 051752 63.97-20.87 1 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	17	59	13	1.0	15	2.3	4.59	4.71
			17	1.8z			4.37	4.49
UPP	18	85	16	1.3	12	0.7	4.42	4.54
			17	1.1z			4.19	4.31
MOX	22	113	12	1.3			4.65	4.75
			12	1.8z			4.70	4.80
PRU	23	110	18	1.4			4.56	4.65

=> 4.50(0.18)7 => 4.61(0.17)

1967 Jul 28 153501 64.01-20.94 1 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	17	59	12	0.4	16	1.3	4.32	4.42
			15	1.1z			4.21	4.33
UPP	18	86	13	0.8	13	0.5	4.25	4.37
			13	1.0z			4.27	4.39
MOX	22	113	18	0.7			4.21	4.31
			12	0.9z			4.40	4.49

=> 4.28(0.07)6 => 4.38(0.06)

```
1967 Jul 29   022109   63.90-20.80   33                          ISC
 St D   Az    T1   A1   T2   A2        Ms    Msc
KIR 17  58    12   0.3  17   0.7      4.06   4.18
              15   0.5                3.87   3.99
UPP 18  85    14   0.7  14   0.4      4.15   4.27
              13   0.8z               4.17   4.29
MOX 22 112    12   0.5                4.23   4.33
              12   0.6z               4.23   4.33
                                   => 4.11(0.14)6 => 4.23(0.13)

1967 Sep 30   023440   63.80-22.70   13                          ISC
 St D   Az    T1   A1    T2   A2       Ms    Msc
MOX 23 110    12   1.0                4.57   4.66
              13   0.9z               4.40   4.49
                                   => 4.48(0.12)2 => 4.56(0.12)

1967 Sep 30   041944   63.80-22.70m 33                           ISC
 St   D  Az   T1   A1    T2   A2       Ms    Msc
MOX 22 110    14   1.1                4.54   4.64
              14   1.0z               4.38   4.48
                                   => 4.46(0.11)2 => 4.56(0.11)

1967 Sep 30   043007   63.90-22.40m 30                           ISC
 St   D  Az   T1    A1    T2   A2      Ms    Msc
MOX 22 110    11    0.6               4.37   4.47
              11    0.6z              4.27   4.37
                                   => 4.32(0.07)2  => 4.42(0.07)

1967 Oct 04   214752   63.66-19.15   10                         ENG@
 St   D  Az   T1    A1   T2   A2       Ms    Msc
KIR 16   58   17    1.0  16   2.3     4.48   4.61
              16    1.6z              4.30   4.43
MOX 21 144    16    1.2               4.46   4.56
                                   => 4.41(0.10)3 => 4.53(0.09)

1967 Nov 06   054949   67.90-18.90   33                          ISC
 St   D  Az   T1   A1    T2   A2         Ms    Msc
MOX 23 124    16   0.6                  4.23   4.32
              16   0.2z!                3.66   3.75
                                   =>   3.94(0.40)2 => 4.03(0.40)

1968 Jul 30   022450   66.42-17.50   1                           ISC
 St   D  Az   T1   A1    T2   A2         Ms    Msc
KIR 15   67   13   0.9   20   0.9       4.12   4.26
              18   1.3z                 4.11   4.25
                                   =>   4.11(0.01)2 => 4.25(0.01)
```

1968 Nov 08 161116 64.39-18.10 33 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
MOX	21	117	13.5	2.6			4.87	4.97
			13	2.8z			4.83	4.93
PRU	22	114	12	0.6			4.24	4.34
			12	1.1z			4.49	4.59

=> 4.61(0.30)4 => 4.71(0.30)

1968 Dec 5 094413 63.90-21.81 5 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	17	58	11	21	14	41	5.92	6.04
			14	47z			5.87	5.99
UPP	19	84	13	26	12	15	5.79	5.90
			13	22z			5.65	5.76
MOX	22	111	12	31.3			6.04	6.14
			12	41.6z			6.07	6.17
PRU	24	109	12	32			6.11	6.20
			12	10z			5.51	5.60
PRA	24	109	11	20.5z			5.85	5.94
FUR			14	32z			5.95	6.04

=> 5.87(0.19)10 => 5.97(0.19)

1969 Apr 1 041044 66.45-17.67 9 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	14	67	14	1.1	13	0.6	4.20	4.35
			16	1.0			4.00	4.15
UPP	17	96	15	0.7	13	0.6	4.16	4.28
			15	0.7z			4.01	4.13
MOX	21	122	16	1.0			4.31	4.41
			16	0.6z			4.07	4.17

=> 4.12(0.12)6 => 4.25(0.12)

1969 May 5 214729 66.90-18.28 1 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	15	69	14	6.4	15	8.0	5.08	5.22
			18	11z			5.04	5.18
UPP	17	97	17	3.1	14	2.6	4.77	4.89
			18	2.3z			4.45	4.57
MOX	22	123	18	7.7			5.26	5.36
			16	5.1z			5.03	5.13
PRA	23	120	17.5	6.4			5.14	5.23
PRU	24	120	17	6.0			5.23	5.32
FUR	24	126	11	2.8			5.10	5.19

=> 4.99(0.23)9 => 5.09(0.24)

1969 Aug 26 224724 66.44-17.51 8 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	15	68	14	1.3	17	1.4	4.32	4.46
			13	0.9z			4.09	4.11

UPP	17	96	16	0.8	12	0.4	4.14	4.26
			14	0.7z			4.04	4.16
MOX	22	122	19	1.0			4.34	4.44
			12	0.8z			4.35	4.45
PRU	23	119	14	0.7			4.36	4.45

=> 4.23(0.14)7 => 4.33(0.15)

1969 Aug 26 224907 66.51-17.80 33 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	67	14	0.6			3.97	

=> 3.97(-)01 => 4.11

1970 Nov 06 071545 63.84-23.20 8 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	58			12	1.1	4.44	4.56
			12	0.4z			3.91	4.03
MOX	23	109	16	1.2			4.52	4.61
			11	1.6z			4.72	4.81
FUR	24	114	19	(1.3)			4.54	4.63

=> 4.43(0.30)5 => 4.53(0.29)

1970 Nov 06 112525 63.70-23.30 33 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	57	14	1.1	14	1.1	4.43	4.55
			14	0.7z			4.08	4.20
MOX	23	109	15	1.0			4.47	4.56
			14	1.4z			4.56	4.65

=> 4.39(0.21)4 => 4.49(0.20)

1971 May 13 200846 63.90-23.20 33 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	23	109	15	0.4			4.07	

=> 4.07(-)01 => 4.16

1971 Aug 29 105617 67.69-18.92 22 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	71	15	2.2	15	4.1	4.72	4.86
			15	3.7z			4.64	4.78
UPP	18	100	15	2.1	20	1.2	4.52	4.64
			17	3.4z			4.68	4.80
MOX	23	124	17	2.0			4.52	4.61
			12	1.4z			4.63	4.72
PRA	24	120	18	1.8			4.69	4.78
PRU	24	120	15	1.7			4.75	4.84
FUR	25	127	13	3.2z			5.00	5.08
TUL	52	274					4.88	4.89
TUL	52	274		z			4.63	4.64

=> 4.70(0.14)11 = 4.79(0.14)

1971 Nov 19 025747 63.75-22.90 5 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	58	14	1.4	12	0.7	4.46	4.58
			14	0.7z			4.08	4.20
MOX	22	109	12.5	1.3			4.66	4.76
			12.5	1.6z			4.64	4.74
PRU	24	107	12.0	0.8			4.52	4.61
FUR	24	114	15.0	2.5z			4.82	4.91
MOS	30	77					4.5	4.56

=> 4.53(0.23)7 => 4.62(0.22)

1971 Nov 19 055705 63.84-22.66 12 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	58	14	0.9			4.28	4.40
MOX	23	110	12	0.6			4.34	4.43
			12	0.8z			4.38	4.47

=> 4.33(0.05)3 => 4.43(0.04)

1972 Jan 01 130117 63.90-22.17m 4 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	22	111	13	1.1			4.56	

=> 4.56(-)01 => 4.66(-)01

1973 Apr 1 085111 67.69-19.03 10 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	71	19	1.3	15	2.0	4.40	4.54

1973 Sep 15 014559 63.82-22.31 1 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	58	12	6.6	14	12.0	5.39	5.51
			15	12.0z			5.25	5.37
UPP	19	84	15	5.8	20	2.7	4.98	5.09
			13	6.7z			5.13	5.24
MOX	22	111	12	5.4			5.29	5.39
			11.5	9.2z			5.43	5.53
STU	23	117z					5.21	5.30
STU	23	117					5.39	5.48
FUR	24		17	11.8			5.53	5.62
PRA	24	108	19	8.4			5.23	5.32
			19	5.5z			5.05	5.14
PRU	24	108					5.14	5.23
PMR	49	329z					5.54	5.55
PMR	49	329					5.53	5.54
TUL	51	274z					4.76	4.77
TUL	51	274					5.33	5.34
BKS	61	297z					5.11	5.10
BKS	61	297					5.93	5.92
MAT	78	16z					5.19	5.15

MAT	78	16					5.05	5.01

=> 5.26(0.25)19 => 5.31(0.25)

1973 Sep 16 212656 63.87-22.35 6 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	16	58	12	6.6	14	8.5	5.28	5.41
			16	8.9			5.04	5.27
UPP	19	84	17	3.3	14	2.6	4.85	4.96
			14	5.9			5.05	5.16
MOX	22	110	12	7.9			5.45	5.55
			12	10z			5.45	5.55
NUR	22	77z					(5).22	(5).32
NUR	22	77					(5).28	(5).38
STU	23	117z					5.29	5.38
STU	23	117					5.26	5.35
PRU	24	108					5.01	5.10
PRA	24	108	20	6.0			5.16	5.25
			20	5.8z			5.05	5.14
COL	45	331z					5.36	5.38
PMR	49	329z					5.29	5.30
PMR	49	329					5.48	5.49
TUL	51	274z					4.79	4.80
TUL	51	274					5.02	5.03
MAT	79	16z					5.17	5.13
MAT	79	16					4.95	4.91

=> 5.18(0.20)18 => 5.23(0.21)20

1973 Sep 16 223333 63.90-22.10 34 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	58	11	0.4	14	0.8	4.22	4.34
			14	0.6z			3.97	4.09
UPP	19	84	14	0.6	15	0.4	4.10	4.21
			15	0.5z			3.95	4.06

=> 4.06(0.13)4 => 4.17(0.13)

1973 Oct 28 111159 67.12-19.17 6 ENG@

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
NUR	20	88z					4.11	4.22
NUR	20	88					3.87	3.98
MOX	22	122	12	0.6			4.34	4.44
			16	0.5z			4.02	4.12

=> 4.09(0.20)4 => 4.19(0.19)

1973 Oct 28 113141 67.11-19.06 3 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	69	15	1.7	15	2.7	4.57	4.71
			16	2.1			4.37	4.51
UPP	18	97	21	1.9	17	1.0	4.42	4.54
			17	2.5			4.55	4.67
NUR	20	88z					4.59	4.70

St	D	Az	T1	A1	T2	A2	Ms	Msc
NUR	20	88					4.46	4.57
MOX	22	122	18	1.2			4.47	4.57
			13	1.4z			4.56	4.66
PRU	24	119	13	1.3			4.59	4.68
PRA	24	119z					4.40	4.49
PRA	24	119					4.51	4.60

=> 4.50(0.08)11 = 4.61(0.08)

1973 Oct 28 142553 67.18-19.25 33 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	15	69	16	1.2	15	1.1	4.27	4.41
			14	1.0			4.11	4.25
NUR	20	88z					4.24	4.35
NUR	20	88					4.04	4.15
MOX	22	122	19	0.6			4.14	4.24
			18	0.7z			4.12	4.22

=> 4.17(0.11)6 => 4.27(0.09)

1974 Mar 30 184126 63.83-23.20 33 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
PRU	24	119	12	0.7			4.46	

=> 4.46(-)01 => 4.55(-)

1974 Mar 30 191000 63.64-23.60 33 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
PRU	24	106	12	0.6			4.30	

=> 4.30(-)01 => 4.39(-)

1974 Mar 30 201639 63.48-23.50 60! ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	18	57	12	0.5			4.11	4.23
PRU	24	106	12	0.6			4.40	4.49

=> 4.25(0.20)2 => 4.36(0.18)

1974 May 17 142730 64.66-21.28 9 EMG

St	D	Az	T1	A1	T2	A2	Ms	Msc
DUR	14	126	10	4.0			4.80	4.95
KIR	17	60	13	1.3	16	1.5	4.47	4.59
			17	1.0			4.11	4.23
UPP	18	87	14	0.7	12	0.6	4.25	4.37
			14	0.6			4.02	4.14
PRA	24	111	12	1.1			4.64	4.73
			12	0.9z			4.47	4.56
PRU	24	111	10	0.9			4.64	4.73

=> 4.42(0.27)8 => 4.54(0.27)

1974 May 18 233955 64.64-21.28 10 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	61	13	0.7	12	0.5	4.17	4.29
UPP	18	87	15	0.7	14	0.5	4.17	4.29
			12	0.5z			3.96	4.08
PRU	24	111	12	0.5			4.30	4.39

=> 4.15(0.14)4 => 4.26(0.13)

1974 Jun 12 160859 64.76-21.00 5 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	61	15	1.1	11	0.8	4.35	4.47
			13	0.7			4.07	4.19
UPP	18	88	15	0.7	13	0.6	4.21	4.33

=> 4.21(0.14)3 => 4.33(0.14)

1974 Jun 12 175511 64.79-21.05 15 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DUR	14	127	13	33			5.71	5.85
KIR	17	61	16	18	17	14	5.47	5.82
UPP	18	87	15	7.1	15	3.4	5.12	5.24
			17	5.0			4.85	4.97
KJF	21	69z					5.52	5.62
KJF	21	69					5.31	5.41
PRA	24	111	14	19			5.81	5.90
			14	8z			5.35	5.44
PRU	24	111					5.12	5.12
TIR	33	115					5.50	5.55
PMR	48	330z					5.49	5.50
PMR	48	330					5.54	5.55
MSO	50	297z					5.75	5.76
MSO	50	297					5.77	5.78
BMO	53	298z					4.82	4.82
BMO	53	298					4.77	4.77

=> 5.35(0.34)16 => 5.42(0.36)

1974 Jun 25 222345 64.66-17.60 9 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	62	14	2.2	17	4.1	4.73	4.87
UPP	17	90	21	1.1	20	1.2	4.23	4.35
			21	2.6			4.44	4.56
KEV	18	54z					4.71	4.83
KEV	18	54					4.50	4.62
KJF	19	71z					5.06	5.17
KJF	19	71					4.81	4.92
NUR	20	83z					4.18	4.29
NUR	20	88					4.08	4.19
MOX	21	119					4.37	4.47
PRA	22	116	16	3.1			4.92	5.02
			16	4.0z			4.93	5.03
PRU	22	116	16	2.9			4.89	4.99

MSO	51	299z					5.38	5.39
MSO	51	299					5.38	5.39
BMO	54	300z					5.31	5.31
BMO	54	300					5.07	5.07

=> 4.76(0.41)17 => 4.85(0.38)

1974 Oct 11 091218 67.45-20.24 11 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
COL	43	330z					5.54	5.57
COL	43	330					5.32	5.35
MSO	49	295z					5.30	5.31
MSO	49	295					5.36	5.37

=> 5.38(0.11)4 => 5.40(0.12)

1974 Dec 29 035005 64.54-17.61 12 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DUR	13	136	10	17!			5.38	5.53
KIR	15	61	15	3.3	18	4.8	4.82	4.96
			15	4.7			4.75	4.89
UPP	17	90	12	2.7	10	1.3	4.77	4.89
			13	1.4z			4.37	4.49
KEV	18	54z					4.80	4.92
KEV	18	54					4.58	4.70
MOX	21	119z					4.87	4.97
PRU	22	116	17	3.3			4.93	5.03
TUL	53	277z					5.23	5.23
TUL	53	277					4.96	4.96

=> 4.86(0.28)11 => 4.96(0.27)

1975 Mar 11 234224 66.20-18.57 13 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	66	13	0.9			4.19	4.33
			13	0.5z			3.84	3.98
UPP	17	94	18	0.8			4.10	4.22
MOX	22	121z					4.05	4.15
MOX	22	121					4.19	4.29

=> 4.07(0.14)5 => 4.19(0.14)

1975 Aug 13 100657 66.59-17.98 33 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	68	14	0.8	12	0.5	4.10	4.24
			15	0.8z			3.98	4.12
UPP	17	96	22	0.9z			3.96	4.08

=> 4.01(0.08)3 => 4.15(0.08)

```
1975 Dec 23  154003  63.87-22.50m  0        4.5(14) 33   ISC
 St  D  Az     T1  A1   T2  A2    Ms   Msc
PRU 24 107     12  1.1             4.65
                                => 4.65( -  ) => 4.74( -  )

1975 Dec 23  160652  63.91-22.09   0                     ISC
 St  D  Az     T1  A1   T2  A2   Ms   Msc
PRU 24 108     12  0.8            4.51
                               => 4.51( -  ) => 4.60( -  )

1975 Dec 24  093355  66.03-16.90   7                     ENG
 St  D Az      T1  A1   T2  A2   Ms   Msc
PRU 23 119     18  0.8            4.30
                               => 4.30( -  ) => 4.39( -  )

1975 Dec 25  220437  66.26-16.41   5                     ENG
 St D     Az   T1  A1   T2  A2   Ms   Msc
KIR 14    67   11  8.2  11  9.9 5.28 5.43
               12  6.9          4.96 5.11
UPP 17    96   22  1.3          4.12 4.24
               28  4.0          4.50 4.62
MOX 21   124                    4.96 5.06
                               => 4.76(0.45)5   => 4.89(0.46)
                                 *4.76(0.19)5

1975 Dec 29  104512  66.05-16.91   2                     ENG
 St  D   Az   T1  A1   T2  A2  Ms    Msc
PRU  23  120  16  2.5          4.84  4.93
TUL  53  277z                  5.29  5.29
                              => 5.07(0.31)2 => 5.11(0.25)

1976 Jan 01  003241  66.10-16.76   2                     ENG
 St D    Az   T1  A1   T2  A2   Ms    Msc
MOX 21   123                   4.38  4.48
                              => 4.38( -  )  => 4.48 ( -  )

1976 Jan 04  042928  66.09-16.70   6                     ENG
 St D    Az    T1  A1   T2  A   Ms    Msc
KIR 14  66     12  2.6         4.66  4.81
MOX 21 123                     4.62  4.72
STU 22 129z                    4.63  4.73
STU 22 129                     5.00  5.10
PRU 23 120     17  3.3         4.84  4.93
PMR 48 332                     4.57  4.58
                              => 4.72(0.16)6  => 4.81(0.18)
```

1976 Jan 06 085005 65.75-16.79 28 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	16	65	10	(0.)1			4.32	4.45
MOX	21	122z					4.12	4.22
MOX	21	122					4.27	4.37

=> 4.24(0.10)3 => 4.35(0.12)

1976 Jan 09 034653 66.06-16.72 1 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	21	123	18	1.0			4.34	4.45
PRU	23	120	15	1.8			4.74	4.83
TUL	53	277z	20	1.6			5.07	5.07

=> 4.72(0.36)3 => 4.78(0.31)

1976 Jan 13 132917 66.28-16.57 4 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	14	67	12	223	12	139	6.56	6.71
			15	153z			6.21	6.36
UPP	16	96	17	59	15	80	6.11	6.24
			15	87			6.06	6.19
STU	22	130z					6.25	6.35
PRU	23	120					6.48	6.57
KHC	23	123	15	43z			6.02	6.11
			17	92			6.39	6.48
COL	45	333z					6.48	6.50
COL	45	333					6.33	6.35
PMR	48	332z					6.39	6.40
TUL	53	277z					(7.02	7.02)
TUL	53	277					6.55	6.55
CAR	65	237z					6.19	6.17
CAR	65	237					6.07	6.05
MAT	75	21z					6.25	6.22
MAT	75	21					6.11	6.08

=> 6.28(0.18)16 => 6.33(0.19)16

1976 Jan 18 082347 65.69-16.95 10 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	65	14	1.8	13	1.1	4.43	4.57
			11	1.1z			4.25	4.39

=> 4.34(0.13)2 => 4.48(0.13)

1976 Jan 19 092250 65.69-16.95 17 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
PRU	22	119	12	0.9			4.52	4.62

=> 4.52(-) => 4.62(-)

1976 Jan 31 224030 65.64-16.91 10   ENG

```
 St D   Az    T1  A1    T2  A2    Ms    Msc
KIR 15  65    11  1.4   13  1.7   4.50  4.64
              11  1.2z            4.29  4.43
MOX 21 122z                       4.47  4.57
PMR 48 332                        4.57  4.58
                               => 4.46(0.12)4  => 4.56(0.09)
```

1976 Feb 02 131647 66.10-16.74   1   ENG

```
 St D   Az    T1  A1    T2  A2    Ms    Msc
KIR 14  66    11  2.6   14  2.2   4.66  4.81
              11  1.2             4.24  4.39
UPP 17  96    16  2.0   13  1.2   4.53  4.65
              15  3.0             4.64  4.76
KHC 23 122    12  1.9             4.86  4.95
PMR 48 332z                       4.39  4.40
                             =>   4.55(0.22)6 => 4.66(0.23)
```

1976 Mar 06 202657 66.57-17.89 1   ENG

```
 St D   Az    T1  A1    T2  A2    Ms    Msc
KIR 15  68    13  2.5             4.62  4.76
UPP 17  96    13  1.7             4.56  4.68
PRU 23 119    17  1.4             4.59  4.68
                               => 4.59(0.03)3 => 4.71(0.04)
```

1976 Jul 27 040054 64.69-17.38   1   ENG

```
 St D   Az    T1  A1     T2  A2    Ms    Msc
KIR 15  61    11  2.9    10  2.3   4.81  4.95
              15  4.1              4.69  4.83
UPP 17  90    11  2.7    11  1.2   4.76  4.88
              10  2.6              4.76  4.88
PRU 22 116    16  3.7              5.00  5.10
KHC 23 119    16  2.2              4.80  4.89
PMR 49 332z                        4.76  4.77
MAI 52  84z                        4.68  4.69
BKS 62 300z                        5.21  5.20
BKS 62 300                         5.50  5.49
MAT 77  20                         4.83  4.79
                             => 4.89(0.25)11 => 4.95(0.23)11
```

1977 May 16 164748 63.91-22.31   8   ENG

```
 St D   Az   T1  A1    T2  A2    Ms    Msc
KIR 17  58   14  2.0   15  1.6   4.61  4.73
             15  1.6             4.37  4.49
UPP 19  84   13  1.1   12  1.1   4.51  4.62
             13  1.6             4.51  4.62
KHC 24 111   18  1.5z            4.52  4.61
             16  1.8             4.64  4.73
PRU 24 108                       4.52  4.61
```

SKO	33	110z					4.81	4.86
SKO	33	110					5.11	5.16

=> 4.62(0.22)9 => 4.71(0.20)9

1977 Jun 02 145533 63.63-19.18 1 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	16	58	17	10.0	14	4.0	5.16	5.29
			14	4.2			4.78	4.91
UPP	17	86	15	7.1	17	2.6	5.04	5.16
			14	4.1			4.81	4.93
PRU	22	114	16	9.0			5.49	5.59
PMR	50	331z					4.72	4.73
MSO	51	229z					5.42	5.43
TUL	53	277z					5.02	5.02
TUL	53	277					4.82	4.82

=> 5.03(0.27)9 => 5.10(0.29)

1977 Jul 01 183108 64.61-17.80 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	21	118					3.87	3.97

=> 3.87(-) => 3.97(-)

1977 Dec 28 203241 64.63-17.38 1 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	61	15	3.3	17	5.4	4.86	5.00
			15	5.5			4.82	4.96
UPP	17	90	18	2.2	18	1.4	4.49	4.61
			20	4.4			4.68	4.80
KEV	18	54					4.87	4.99
KJF	19	71z					5.06	5.17
	19	71					4.88	4.99
NUR	19	83z					4.84	4.95
NUR	19	83					4.69	4.80
PRU	22	116					5.04	5.14
KHC	22	119	17	3.3z			4.83	4.93
			17	2.5			4.93	5.03
PMR	49	332z					4.98	4.99
MSO	52	299z					5.52	5.53
MAI	52	84z					4.90	4.91
BKS	62	300z					5.46	5.45
BKS	62	300					5.53	5.52

=> 4.96(0.29)17 => 5.05(0.25)

1978 Jan 09 091542 65.98-16.99 10 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
SAL	15	98z					4.04	4.18

=> 4.04(-) => 4.18(-)

1978 Jan 09 135406 65.95-16.98 10   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 15  98z                        4.05  4.19
PRU 23 119                         4.49  4.58
                               => 4.27(0.31)2 => 4.39(0.25
```

1978 Jan 09 190312 65.91-16.99 1   ENG

```
 St D    Az    T1   A1    T2   A     Ms    Msc
HFS 15  99z                        4.17  4.31
FUL 22  84z                        4.61  4.71
FUL 22  84                         4.71  4.81
ARU 35  68z                        4.75  4.80
                               => 4.56(0.27)4 => 4.66(0.24)
```

1978 Jan 09 200248 65.98-17.00 13   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 15  98z                        3.69  3.83
                               => 3.69( -  ) => 3.83( -  )
```

1978 Jan 10 015625 65.98-17.00 10   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 15  98z                        4.13  4.27
                               => 4.13( -  ) => 4.27( -  )
```

1978 Jan 10 103857 66.01-16.80 10   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 15  99z                        3.49  3.63
                               => 3.49( -  ) => 3.63( -  )
```

1978 Jan 10 124514 65.94-16.64 15   ENG

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
SLL 14  98z                        3.68  3.83
                               => 3.68( -  ) => 3.83( -  )
```

1978 Jan 10 174215 65.98-17.00 10   ENG

```
 St D    Az    T1   A1    T2         Ms    Msc
HFS 15  99z                      4.34  4.48
PRU 23 119                       4.73  4.82
NRI 35  36                       4.40  4.45
TAS 52  73                       4.84  4.85
                             => 4.58(0.24)4 => 4.65(0.21
```

1978 Jan 10 192532 66.03-16.80 10   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 15  99                         3.42  3.56
                               => 3.42( -     => 3.56  -
```

1978 Jan 11 105815 65.95-16.91   9 **ENG**

```
 St D   Az    T1  A1   T2  A   Ms   Msc
HFS 15   99z                  4.14  4.28
APA 19   63z                  4.20  4.31
PUL 22   84z                  4.50  4.60
                          => 4.28(0.19)3 => 4.40(0.18)
```

1978 Jan 13 003123 66.01-16.94   3 **ENG**

```
 St D   Az    T1  A1   T2  A2  Ms   Msc
SLL 14  98z                   3.49  3.64
MOX 21 123z                   3.90  4.00
TUL 53 277                    4.32  4.32
                          => 3.90(0.41)3 = 4.00(0.34)
```

1978 Jun 21 232942 64.64-17.60   0 **ISC**

```
 St D   Az    T1  A1   T2  A2   Ms   Msc
APP 15  91z                    3.73  3.87
                           => 3.73( -  ) => 3.87( -  )
```

1978 Sep 06 192309 64.45-18.20 10 **ISC**

```
 St D   Az    T1  A1   T2  A2   Ms   Msc
MOX 21 117                     3.89  3.99
                           => 3.89( -  ) => 3.99( -  )
```

1979 Apr 1 043131 64.51-17.60   5 **ISC**

```
 St D   Az    T1  A1   T2  A2   Ms   Msc
HFS 15  92z                    2.96  3.10
                           => 2.96( -  ) => 3.10( -  )
```

1979 Apr 30 232801 66.53-17.95 10 **ISC**

```
 St D   Az    T1  A1   T2  A2   Ms   Msc
HFS 15  99z                    3.45  3.59
                           => 3.45( -  ) => 3.59( -  )
```

1979 Jun 22 231801 64.53-17.55   7 **ENG**

```
 St D   Az    T1  A1   T2  A2     Ms    Msc
KIR 15  61    11  2.4  13  2.8   4.76  4.90
              13  2.2            4.30  4.44
HFS 15  93z                      4.35  4.49
WOL 16 140z                      4.84  4.97
DBN 17 126                       5.03  5.15
UPP 17  90    12  2.5  11  0.8   4.69  4.81
              12  2.5            4.26  4.38
KJF 19  70z                      4.70  4.81
APA 20  59z                      4.53  4.64
MOX 21 119z                      5.07  5.17
```

```
MOX 21 119                           5.16  5.26
GRF 21 121z                          5.03  5.13
STU 21 125z                          4.96  5.06
PUL 22  80z                          4.64  4.74
PUL 22  80                           4.69  4.79
KHC 23 118z                          4.59  4.68
KHC 23 118                           4.82  4.91
SRO 26 114                           4.95  5.03
LVV 26 104z                          4.99  5.07
UZH 26 108z                          4.98  5.06
UZH 26 108                           5.08  5.16
KIS 30 103                           4.91  4.97
SKO 32 117z                          5.18  5.24
SIM 34 100                           5.23  5.28
ARU 36  66z                          4.94  4.99
ARU 36  66                           4.93  4.98
SVE 37  64z                          4.99  5.03
SVE 37  64                           4.84  4.88
GRO 41  90                           5.62  5.65
LEN 42  94z                          4.49  4.52
LEN 42  94                           4.65  4.68
TIK 42  15z                          4.32  4.35
TIK 42  15                           4.38  4.41
NVS 46  52z                          4.86  4.88
NVS 46  52                           4.91  4.93
LIT 47 350z                          5.22  5.24
LIT 47 350                           5.13  5.15
ASH 51  83z                          5.37  5.38
TAS 52  72z                          4.45  4.46
TAS 52  72                           4.85  4.86
FRU 53  67                           5.10  5.10
ANR 54  70z                          5.18  5.18
ANR 54  70                           5.12  5.12
IRK 55  40z                          5.10  5.10
IRK 55  40                           5.13  5.13
MGD 55   7z                          4.94  4.94
MGD 55   7                           5.04  5.04
YAK 57  41                           4.91  4.91
                                => 4.88(0.30)48 => 4.94(0.28)48

1980 May 05 132226  64.51-17.50  10                             ISC
 St D    Az    T1   A1    T2   A2     Ms    Msc
[illegible]FS 15  92z                          2.91  3.05
                                  => 2.91( -  ) => 3.05( -  )

1980 May 17 211530  63.15-24.49  10                             ISC
 St D    Az    T1   A1    T2   A2    Ms    Msc
[illegible] 18  83z                          3.73  3.85
                                 => 3.73( - , ) => 3.85) -  )
```

1980 Aug 12 121149 64.69-17.33 26 **ENG**

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	15	61	14	6.1z			4.90	5.05
SLL	15	93z					4.81	4.95
UPP	17	90	12	6.4z			5.06	5.18
COP	17	108z					4.93	5.05
KEV	18	54z					4.66	4.78
KJF	19	71z					5.35	5.46
NUR	19	83z					4.94	5.05
MOX	21	119z					5.22	5.32
MOX	21	119					5.39	5.49
HOF	21	119z					5.16	5.26
GRF	22	121z					5.34	5.44
PRU	22	116z					5.18	5.28
PRU	22	116					5.14	5.24
KHC	23	119z					4.89	4.98
KHC	23	119					4.98	5.07
KRA	24	109z					4.90	4.99
KRA	24	109					5.03	5.12
COL	46	333z					5.08	5.10
MSO	52	299z					4.78	4.79
GOL	54	288z					5.29	5.29
MAT	77	20z					5.17	5.13

=> 5.06(0.20)21 => 5.14(0.20)21

1980 Aug 20 142538 62.70-25.33 20 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	54	20	0.5z			3.83	3.94
HFS	19	80z					4.07	4.18
UPP	20	79	20	0.5z			3.87	3.98
MOX	23	104z					4.57	4.66
MOX	23	104					4.52	4.61
GRF	24	106					4.82	4.91
PRU	25	102z					4.06	4.14
PRU	25	102					4.38	4.46
SRO	27	101z					4.49	4.57
TUL	50	272z					4.64	4.65
BKS	60	295z					5.07	5.06
BKS	60	295					5.09	5.08

=> 4.45(0.43)12 => 4.52(0.39)

1980 Aug 20 150559 62.70-25.28 9 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	55	15	0.6z			4.03	4.14
HFS	19	81z					4.16	4.27
MOX	23	105z					4.65	4.74
MOX	23	105					4.55	4.64
GRF	24	107z					4.88	4.97
PRU	25	102z					4.43	4.51
PRU	25	102					4.51	4.59
KHC	25	105z					4.36	4.44

```
KHC 25 105                      4.50  4.58
                              => 4.45(0.25)9 => 4.54(0.25)

1980 Dec 25 113730  66.51-17.68 12                        ENG
 St D    Az  T1  A1    T2 A2  Ms    Msc
KIR 15   68  18  3.1z        4.47  4.61
HFS 15 100z                  4.37  4.51
MOX 22 123z                  4.65  4.75

MOX 22 123                   4.64  4.74
PRA 25 113z                  4.68  4.76
PRA 25 113                   4.86  4.94
TUL 53 276z                  5.08  5.08
                            => 4.68(0.24)7 => 4.77(0.19)

1980 Dec 25 114353  66.56-17.74  10                       ENG
 St D    Az    T1  A1   T2 A2  Ms    Msc
HFS 15 100z                  3.73  3.87
                            => 3.73( -  ) => 3.87( -  )

1980 Dec 25 115743  66.63-17.38  10                       ISC
 St D    Az    T1  A1 T2  A2  Ms    Msc
HFS 15 100z                  3.26  3.40
                            => 3.26( -  ) => 3.40( -  )

1980 Dec 26 004521  55.50-17.86  10                       ISC
 St D    Az    T1  A1  T2  A2  Ms    Msc
SLL 15   99z                  2.97  3.11
                              => 2.97( -  ) => 3.11( -  )

1980 Dec 26 014640  66.39-18.17  10                       ISC
 St D    Az    T1  A1  T2  A2  Ms    Msc
SLL 15   98z                  3.46  3.60
                              => 3.46( -  ) => 3.60( -  )

1980 Dec 26 050056  66.38-18.04 12                        ISC
 St D    Az    T1  A1  T2  A2  Ms    Msc
HFS 15   99z                  3.71  3.85
                              => 3.71( -  ) => 3.85( -  )

1980 Dec 26 050257  66.42-17.89  8                        ENG
 St D    Az    T1  A1 T2  A2   Ms    Msc
SLL 15   99z                  3.93  4.07
NUR 20   87z                  4.02  4.13
ALQ 58 284z                   4.82! 4.81
                              => 4.26(0.49)3 => 4.34(0.42)
```

1982 Nov 08 124327 62.70-24.55 1 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
NUR	23	74z					3.54	3.63
MOX	23	106z					4.41	4.50
MOX	23	106					4.45	4.54
PRU	25	104z					4.35	4.43
PRU	25	104					4.42	4.50
KRA	27	98z					4.65	4.73
ALQ	56	281z					4.65	4.65

=> 4.36(0.38)7 => 4.43(0.37)

1983 Apr 06 135758 61.80-25.60 10 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	20	53	14	1.0z			4.31	4.42
UPP	21	76	23	1.3z			4.24	4.34
KRA	27	94z					4.66	4.74

=> 4.40(0.22)3 => 4.50(0.21)

1983 May 16 153548 63.51-23.74 1 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KJF	22	65z					4.73	4.63
NUR	22	79z					3.96	4.06
MOX	23	108z					4.55	4.64
MOX	23	108					4.59	4.68
PRU	24	106z					4.52	4.61
PRU	24	106					4.59	4.68

=> 4.47(0.25)6 => 4.55(0.24)

1983 May 16 154159 63.52-23.48 5 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	57	15	0.8z			4.12	4.24
UPP	19	82	10	2.0z			4.74	4.85
KJF	22	65z					4.93	5.03
NUR	22	76z					4.35	4.45
MOX	23	108z					4.98	5.07
MOX	23	108					4.87	4.96
GRF	23	110z					4.35	4.44
PRU	24	106z					4.83	4.92
PRU	24	106					4.90	4.99
KHC	25	108z					4.83	4.91
KHC	25	108					4.94	5.02

=> 4.71(0.29)11 => 4.81(0.29)

1983 Jul 11 194201 63.47-23.90 4 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	113z					3.82	3.93

St	D	Az	T1	A1	T2	A2	Ms	Msc
GRF	23	109z					4.21	4.30

=> 4.02(0.28)2 => 4.12(0.26)

1983 Jul 11 202641 63.36-23.90 1 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	18	57	18	1.9z	-	-	4.42	4.54
DBN	19	113z					4.40	4.51
KEV	21	50z					4.31	4.41
GRF	23	109z					4.64	4.73
KRA	27	99z					4.86	4.94
KRA	27	99					4.93	5.01

=> 4.59(0.26)6 => 4.69(0.24)

1983 Jul 20 094441 64.46-17.81 10 **ISC**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	21	118z					4.52	4.62
MOX	21	118					4.46	4.56

=> 4.49(0.04)2 => 4.59(0.04)

1984 Apr 24 082251 62.97-24.89 15 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DBN	19	111z					4.09	4.20
KIR	23	74z					4.17	4.26
MOX	23	105z					4.57	4.66
MOX	23	105					4.60	4.69
KHC	25	106z					4.15	4.23
KHC	25	106					4.23	4.31
PRU	25	103z					4.27	4.35
PRU	25	103					4.60	4.68
[illegible]	34	106z					4.46	4.69
[illegible]	34	106					4.44	4.49

=> 4.36(0.20)10 => 4.46(0.21)

1984 Sep 30 233156 64.56-17.55 4 **ENG**

[illegible]	[illegible]	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
[illegible]	15	61	14	2.2z			4.47	4.61
[illegible]	17	70	10	1.8z			4.59	4.71
[illegible]	[illegible]	126z					4.44	4.52
[illegible]	19	53z					4.70	4.82
[illegible]	19	70z					4.76	4.87
[illegible]	[illegible]	82z					4.10	4.21
[illegible]	[illegible]	118z					4.80	4.90
[illegible]	[illegible]	118					4.94	5.04
[illegible]	[illegible]	125z					4.53	4.63
[illegible]	[illegible]	115z					4.71	4.81
[illegible]	[illegible]	115					5.02	5.12
[illegible]	[illegible]	120z					4.58	4.68
[illegible]	[illegible]	118z					4.38	4.47
[illegible]	[illegible]	118					4.71	4.80

VKA	24	116z					4.88	4.97
KRA	24	108z					4.75	4.84
KRA	24	108					4.87	4.96
JCT	60	278z					4.99	4.98

=> 4.68(0.24)18 => 4.77(0.23)18

1984 Nov 10 084034 61.78-29.21 37 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
SLL	19	76z					4.97	5.08
APO	20	75z					4.97	5.08
DBN	20	104z					4.59	4.67
UCC	20	108z					5.20	5.31
DOU	21	109z					4.85	4.95
COP	21	89z					4.74	4.84
KIR	21	52	10	1.2z			4.58	4.68
UPP	22	74	19	4.1z			4.88	4.98
LOR	23	115z					4.33	4.42
MOX	24	100z					5.10	5.19
MOX	24	100					5.58	5.67
GRF	24	102z					5.08	5.17
NUR	24	70z					4.61	4.70
KHC	26	100z					4.92	5.00
KHC	26	100					4.77	4.85
KRA	28	93z					4.95	5.02
KRA	28	93					4.94	5.01
OBN	33	72z					4.85	4.90
SKO	35	102z					4.74	4.79
SKO	35	102					4.91	4.96
RSO	37	284z					5.28	5.32
YKA	38	311z					5.22	5.26
RSS	46	285z					5.36	5.38
TUL	49	271z					4.46	4.47
ALQ	55	280z					5.42	5.42
JCT	55	271z					5.32	5.32

=> 4.95(0.31)26 => 5.02(0.30)

1985 Jun 25 103131 64.61-20.78 8 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	16	90z					4.21	4.34
UPP	18	89	17	0.9z			4.12	4.24
DBN	18	121z					4.30	4.42
COP	19	103z					4.36	4.47
DOU	20	126z					4.50	4.61
MOX	22	114z					4.70	4.80
MOX	22	114					4.50	4.60
GRF	23	116z					4.29	4.38
PRU	24	112z					4.66	4.75
PRU	24	112					4.63	4.72
KHC	24	114z					4.43	4.52
KHC	24	114					4.44	4.53
VKA	26	112z					4.76	4.84

```
KRA 26 105z                          4.75  4.83
KRA 26 105                           4.74  4.82
                                  => 4.49(0.21)15 => 4.60(0.19)
```

1985 Jun 26 133856 64.67-20.80 10   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 16   90z                         3.54  3.67
MOX 22 114z                          3.93  4.03
MOX 22 114                           3.72  3.82
PRU 24 112z                          4.10  4.19
                                  => 3.82(0.24)4 => 3.93(0.23)
```

1985 Jun 28 164446 64.60-20.60m 3   ISC

```
 St D    Az    T1   A1    T2   A2    Ms    Msc
HFS 16   89z                         3.56  3.69
GRB 23 116                           3.60  3.69
                                  => 3.58(0.03)2 => 3.69(0.00)
```

1985 Aug 30 184714 67.71-19.01 10   ISC

```
 St D    Az     T1   A1    T2   A2    Ms    Msc
KIR 15   71     14   1.5z             4.27  4.41
UPP 18   98     16   1.9z             4.44  4.56
DBN 20 131z                           3.99  4.10
GRF 24 125z                           3.86  3.95
PRU 24 120z                           4.20  4.29
PRU 24 120                            4.34  4.43
KHC 25 122z                           4.45  4.53
KHC 25 122                            4.45  4.63
                                  => 4.26(0.24)8 => 4.36(0.24
```

1985 Aug 30 190143 67.65-18.88 15   ENG

```
 St D    Az    T1   A1    T2   A2   Ms    Msc
KIR 14   71    15   3.0z            4.53  4.68
UPP 17   99    17.  4.3z            4.77  4.89
KJF 19   79z                        4.81  4.81
DBN 19 132z                         4.39  4.50
MOX 23 124z                         4.39  4.48
MOX 23 124                          4.66  4.75
GRF 23 126z                         4.57  4.66
KHC 25 123z                         4.84  4.92
KHC 25 123                          4.64  4.72
                                => 4.62(0.17)9 => 4.71(0.15)
```

1985 Dec 24 105205 67.73-18.70 10   ISC

```
 St D    Az    T1   A1    T2   A2   Ms    Msc
NUR 20   90z                        3.77  3.88
GRF 23 125z                         4.08  4.17
                                => 3.91(0.19)2 => 4.02(0.20)
```

1986 Apr 02 084134 62.63-25.37 10 **ENG**

St	D	Az	T1	A1	T2	A2	Ms	Msc
PRU	25	102z					4.39	4.47

=> 4.39(-) => 4.47(-)

1986 Apr 02 084642 62.69-25.28 10 **ENG**

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	19	55	13	1.5z			4.49	4.60
HFS	19	80					4.64	4.75
DBN	19	109					4.74	4.85
UPP	20	79	18	1.9z			4.50	4.61
DOU	21	114z					4.55	4.65
MOX	23	104z					5.08	5.17
MOX	23	104					4.99	5.08
GRF	24	106z					5.03	5.12
PRU	25	102z					4.92	5.00
KHC	25	105					4.65	4.73
VKA	27	103z					4.95	5.03
KRA	27	96z					4.92	5.00
SKO	34	105z					4.98	5.03
SKO	34	105					4.14	4.19
TUL	50	272z					5.60	5.61
ALQ	56	281z					5.10	5.10
CHT	88	52z					4.68	4.63

=> 4.82(0.33)17 => 4.89(0.32)

1986 Apr 02 085951 62.73-25.27 8 **ENG**

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	19	55	13	0.9z			4.27	4.38
DBN	19	109z					4.44	4.55
UPP	20	78	18	1.7z			4.45	4.56
GRF	24	106z					4.63	4.72
PRU	25	102z					4.62	4.70
PRU	25	102					4.61	4.69

=> 4.50(0.14)6 => 4.60(0.13)

1986 Apr 02 152617 62.66-25.36 5 **ENG**

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	19	55	13	0.9z			4.27	4.38
HFS	19	80z					4.63	4.74
DBN	19	109z					4.44	4.55
UPP	20	79	19	1.3z			4.31	4.42
MOX	23	104z					4.84	4.93
MOX	23	104					4.81	4.90
CLL	23	101z					4.62	4.71
GRF	24	106z					4.81	4.90
PRU	25	102z					4.69	4.77
PRU	25	102					4.76	4.84
VKA	27	103z					4.80	4.88
KRA	27	96					4.99	5.07

TUL	50	272z					5.33	5.34
ECA	66	131z					4.50	4.48

=> 4.70(0.28)14 => 4.78(0.26)

1986 Apr 02 174003 62.60-25.44 6 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	55	14	0.7z			4.14	4.25
IBN	19	109z					4.25	4.36
UPP	21	78	22	1.2z			4.22	4.32
PRU	25	102z					4.55	4.63
TUL	50	272z					5.09	5.10

=> 4.45(0.39)5 => 4.59(0.31)

1986 Apr 02 174949 62.65-25.29 12 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	55	15	1.9z			4.57	4.68
HFS	19	80z					4.71	4.82
IBN	19	109z					4.77	4.88
UPP	20	78	24	3.0z			4.57	4.68
MOX	23	104z					5.13	5.22
MOX	23	104					5.01	5.10
GRF	24	106z					5.20	5.29
BRG	24	101z					4.97	5.06
BRG	24	101					5.06	5.15
PRU	25	102z					5.02	5.10
PRU	25	102					4.90	4.98
KHC	25	104z					4.79	4.87
VKA	27	103z					5.04	5.12
KRA	27	96					5.12	5.20
IRO	28	101					5.04	5.11
EKO	34	105z					5.05	5.10
EKO	34	105					5.14	5.19
ANT	41	96z					4.66	4.69
MAT	80	13z					4.76	4.72
CHT	88	52z					4.81	4.76

=> 4.92(0.20)20 => 4.99(0.20)

1986 Apr 02 203530 62.40-25.70 10 **ISC**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	19	79z					3.57	3.68

=> 3.57(-) => 3.68(-)

1986 Sep 16 141810 63.36-24.05 10 **ISC**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
ENS	21	112z					4.56	4.66
KJF	22	65z					4.64	4.74
NUR	23	75z					3.47!	3.56
GRF	23	109z					4.37	4.46
PRU	25	195z					4.42	4.50

PRU	25	195					4.27	4.35

=> 4.29(0.42)6 => 4.39(0.43)

1986 Oct 12 233412 66.21-17.43 10 **ISC**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	18	99					3.32	3.44
GRF	22	124z					3.88	3.98

=> 3.60(0.40)2 => 3.71(0.38)

1986 Nov 23 024903 64.65-17.35 7 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DAG	12	359z					5.04	5.20
KIR	15	61	15	3.3z			4.61	4.75
UPP	17	90	20	7.3z			4.89	5.01
KEV	18	54z					5.11	5.23
KJF	19	71z					5.24	5.35
NUR	19	83z					5.04	5.15

=> 4.99(0.22)5 => 5.12(0.21)

1987 May 25 113156 63.91-19.79m 8 **NG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	16	88					5.68	5.81
DBN	17	120z					5.87	5.99
UPP	18	86	13	37z	-	-	5.83	5.95
DOU	19	125z					5.32	5.43
KEV	19	51z					5.65	5.76
KJF	20	67z					5.85	5.96
MOX	21	114z					5.82	5.92
MOX	21	114					5.74	5.84
STU	22	120z					5.62	5.72
GRF	22	116z					5.98	6.08
WET	23	115z					5.84	5.93
PRU	23	111z					5.69	5.78
PRU	23	111					6.22	6.31
FUR	23	118z					6.14	6.23
WAR	24	100z					5.92	6.01
KBA	25	117z					6.21	6.29
VKA	25	111z					5.87	5.95
SRO	26	110					5.75	5.83
RSN	39	312z					6.00	6.04
RSO	40	287z					5.81	5.84
PMR	49	331z					5.92	5.93
TUL	52	276z					6.62	6.63
GLD	53	287z					5.91	5.91
GOL	53	287z					5.74	5.74
JCT	59	276z					5.51	5.50
BKS	62	299					6.73	6.72
CAR	63	234z					5.49	5.48
UPA	69	246z					5.41	5.39
BJI	71	35					6.13	6.10
LZH	71	46					6.12	6.09

SSE	80	33z					6.35	6.31
SSE	80	33					6.08	6.04
ZOB	88	226z					5.75	5.70
LPB	88	226z					5.86	5.81
WIN	91	146z					6.22	6.17
SLR	97	136z					5.92	5.86

=> 5.88(0.26)36 => 5.95(0.29)

1987 Jul 01 175623 64.72-17.67 7 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	21	119z					3.49	3.59
MOX	21	119					3.57	3.67
GRF	21	121					3.55	3.65

=> 3.54(0.04)3 => 3.64(0.04)

1988 Sep 09 144043 66.64-17.84m 3 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	16	99z					3.64	3.77
PRU	23	119z					4.13	4.22
PRU	23	119					4.22	4.31
KRA	25	112z					4.15	4.23
KRA	25	112					4.48	4.56

=> 4.12(0.30)5 = 4.22(0.29)

1988 Sep 12 201917 66.64-17.87m 6 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	15	100					4.06	4.20
UPP	17	96	10	0.9z			4.30	4.42
KJF	19	76z					4.69	4.80
GRF	23	124z					4.17	4.26
PRU	23	119z					4.32	4.41
PRU	23	119					4.54	4.63
VKA	26	119z					4.50	4.58
SKO	33	119					4.68	4.73
WMQ	56	57z					4.86	4.86
LZH	68	48z					4.74	4.72
ZOB	91	228z					4.51	4.46

=> 4.49(0.25)11 => 4.55(0.22)

1988 Sep 12 230019 66.60-18.40 0 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	16	99z					3.28	3.41

=> 3.28 - => 3.41(-)

1989 Feb 03 151826 64.56-17.43 2 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HFS	15	93					4.33	4.47
NUR	20	83z					4.37	4.46
MOX	21	119z					4.79	4.89

MOX	21	119					4.89	4.99
GRF	21	121z					4.71	4.81
SKO	32	117z					4.76	4.82
SKO	32	117					4.99	5.05
GAM	55	73z					5.09	5.09
GTA	65	49z					5.15	5.13
GTA	65	49					5.15	5.13
BJI	70	36z					5.36	5.33
TIY	71	40					5.29	5.26

=> 4.91(0.33)12 => 4.95(0.27)

1989 May 06 234613 64.70-17.45 10 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	21	119z					4.07	4.17
PRU	22	116z					4.24	4.34

=> 4.16(0.12)2 => 4.26(0.12)

1990 Mar 19 104633 63.95-21.93m 6 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
MOX	22	110z					4.70	4.80
KHC	24	110z					4.63	4.72
KHC	24	110					4.50	4.59
PRU	24	108z					4.41	4.50
PRU	24	108					4.72	4.81
KRA	26	101z					4.51	4.59
KRA	26	101					4.74	4.82
SKO	33	110z					4.52	4.57
SKO	33	110					4.50	4.55
GTA	67	45z					4.91	4.89

=> 4.61(0.15)10 = 4.68(0.14)

1990 May 26 025632 63.00-24.72 19 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
GRF	24	108z					3.56	3.65
PRU	25	103z					4.34	4.42
PRU	25	103					4.40	4.48
KHC	25	106z					4.22	4.30
KHC	25	106					4.24	4.32

=> 4.15(0.34)5 => 4.23(0.33)

1990 Sep 15 175203 63.81-22.48 10 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	19	131z					4.03	4.14
LOR	22	126z					3.93	4.03
HAU	22	121z					3.84	3.94
GRF	23	112z					3.56	3.65
RJF	23	132z					4.10	4.19

=> 3.89(0.21)5 => 4.00(0.21)

-1990 Sep 15 230747 64.65-17.60m 21 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	61	13	8.5z			5.08	5.22
UPP	17	90	22	9.6z			4.97	5.09
DBN	17	127z					4.84	4.96
COP	17	108z					3.93	4.05
FLN	18	142z					5.21	5.33
BNS	19	125z					5.31	5.42
NUR	20	83z					5.09	5.20
CLL	21	116z					5.18	5.28
MOX	21	119z					5.29	5.39
MOX	21	119					5.35	5.45
LOR	21	136z					5.45	5.55
HOU	21	131z					5.31	5.41
GRF	21	121z					5.16	5.26
RJF	22	142z					5.23	5.33
PRA	22	116z					5.24	5.34
PRU	22	116z					5.33	5.43
PRU	22	116					5.36	5.46
KHC	23	119z					4.68	4.77
KHC	23	119					5.22	5.31
KRA	24	109z					5.00	5.09
KRA	24	109					5.14	5.23
SKO	32	117z					5.20	5.26
SKO	32	117					5.38	5.44
KSH	57	68					5.64	5.64
KSH	57	68z					5.71	5.71
WMQ	57	56					5.55	5.55
WMQ	57	56					5.38	5.38
LIC	59	166z					4.92	4.91
BKS	62	300z					5.56	5.55
BKS	62	300					5.65	5.64
GTA	65	49					5.47	5.45
GTA	65	49z					5.43	5.41
BTO	67	41					5.75	5.73
HHC	67	40					5.19	5.17
HHC	67	40z					4.81	4.79
CN2	68	28					5.23	5.21
CN2	68	28z					5.56	5.54
MDJ	68	25z					5.09	5.07
BJI	69	36					5.80	5.78
BJI	69	36z					5.73	5.71
SNY	69	30z					5.25	5.23
LZH	70	48					5.55	5.52
LZH	70	48z					5.27	5.24
UPA	70	248z					5.11	5.08
TIY	71	40					5.50	5.47
TIY	71	40z					5.71	5.68
DL2	72	33					5.56	5.53
DL2	72	33z					5.46	5.43
XAN	73	44					5.65	5.62
TIA	73	37					5.23	5.20
TIA	73	37z					5.59	5.56

CD2	74	50z					5.65	5.62
NJ2	78	37z					5.32	5.28
SSE	79	35z					5.51	5.47
KMI	79	53z					5.45	5.41

=> 5.31(0.32)55 => 5.34(0.29)

1990 Oct 30 123038 63.03-24.56 1 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	56	15	1.6z			4.44	4.55
FLN	19	126z					4.81	4.92
LOR	22	122z					4.58	4.68
HAU	23	117z					4.41	4.50
MOX	23	106z					4.52	4.61
CLL	23	103z					4.31	4.40
LJF	23	128z					4.50	4.59
GRF	23	108z					4.19	4.20
PRU	25	103z					4.64	4.72
PRU	25	103					4.58	4.56
KHC	25	106					4.46	4.54
GTA	69	43z					4.98	4.96
BJI	73	31z					4.60	4.57
LZH	73	42z					4.78	4.75
TIY	74	34z					5.02	4.99

=> 4.59(0.23)14 => 4.63(0.21)15

1990 Oct 30 125447 63.08-24.66 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					3.94	4.04
HAU	23	117z					3.86	3.95

=> 3.90(0.06)2 => 4.00(0.06)

1990 Oct 30 130713 63.38-24.11 10 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					4.12	4.22
RJF	23	128z					4.09	4.19
PRU	25	103z					4.38	4.46
KHC	25	106z					4.18	4.26

=> 4.19(0.13)4 => 4.28(0.12)

1990 Oct 30 133551 62.96-24.14 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					4.21	4.31
MOX	23	106z					4.17	4.26
GRF	23	108z					3.83	3.92
KHC	25	106					4.23	4.31

=> 4.11(0.19)4 => 4.20(0.19)

1990 Oct 30 135758 63.26-24.34 10 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					4.26	4.36
HAU	23	117z					4.10	4.19
MOX	23	106z					4.28	4.37
RJF	23	128z					4.20	4.29
GRF	24	108z					4.08	4.17
KHC	25	106z					4.44	4.52
KRA	27	96z					4.54	4.62
ZOB	86	222z					4.17	4.12

=> 4.26(0.16)8 => 4.33(0.17)

1990 Oct 30 140337 63.16-24.29 2 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	19	56	15	1.4z			4.38	4.49
FLN	19	126z					4.66	4.77
LOR	22	122z					4.47	4.57
HAU	23	117z					4.33	4.42
MOX	23	106z					4.49	4.58
CLL	23	103z					4.31	4.40
RJF	23	128z					4.43	4.52
GRF	23	108z					4.08	4.17
PRU	25	104z					4.54	4.62
PRU	25	104					4.61	4.69
KHC	25	106					4.59	4.67
BJI	73	31z					4.60	4.57
LZH	73	42z					4.73	4.69

=> 4.48(0.17)12 => 4.55(0.16)

1990 Oct 30 154731 63.32-24.06 5 **ISC**

St	D	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	123z					4.21	4.31
KHC	25	107z					4.36	4.44

=> 4.28(0.11)2 => 4.38(0.09)

1990 Oct 30 191553 63.22-24.23 13 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	19	127z					4.21	4.32
LOR	22	122z					4.31	4.41
HAU	23	118z					4.13	4.22
RJF	23	129z					4.28	4.37
PRU	25	104z					4.50	4.58
KHC	25	107					4.41	4.49
ZOB	66	222z					4.13	4.11

=> 4.28(0.14)7 => 4.36(0.16)

1990 Oct 30 212340 63.28-24.21 10 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
KIR	19	56	13	0.9z			4.26	4.37
LOR	22	121z					4.50	4.60
NOX	23	105z					4.49	4.58
GRF	24	107z					4.28	4.37
PRU	25	103z					4.47	4.55
PRU	25	103					4.43	4.51
KHC	25	106					4.53	4.61
KRA	27	97z					4.59	4.67
KRA	27	97					4.92	5.00
GTA	69	43z					4.81	4.79
LZH	73	41z					4.67	4.64
TIY	74	34z					4.75	4.72

=> 4.56(0.20)12 => 4.62(0.17)

1990 Oct 30 231005 63.18-24.33 5 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
LOR	22	122z					3.72	3.82
HAU	23	118z					3.53	3.62

=> 3.62(0.13)2 => 3.72(0.14)

1990 Oct 30 234822 63.13-24.41 10 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
LOR	22	122z					3.82	3.92
HAU	23	117z					3.73	3.82
RJF	23	128z					3.74	3.83

=> 3.76(0.05)3 = 3.86(0.05)

1990 Oct 31 005146 63.21-24.16 10 ENG

St	D	Az	T1	A1	T2	A2	Ms	Msc
LOR	22	122z					4.22	4.32
HAU	23	118z					4.10	4.19
MOX	23	106z					4.30	4.39
RJF	23	128z					4.20	4.29
GRF	23	108z					3.86	3.98
PRU	25	104z					4.37	4.45
KHC	25	107					4.33	4.41
KRA	27	98z					4.59	4.67
KRA	27	98					4.78	4.86
WMQ	61	50z					4.36	4.35

=> 4.31(0.25)10 => 4.39(0.24)

1990 Oct 31 034416 63.08-24.78 5 ISC

St	D	Az	T1	A1	T2	A2	Ms	Msc
LOR	22	121z					4.00	4.10
HAU	23	117z					3.93	4.02
RJF	23	128z					3.94	4.03

St	D	Az	T1	A1	T2	A2	Ms	Msc
PRU	25	103z					4.32	4.40

=> 4.05(0.16)4 => 4.14(0.18)

1990 Oct 31 040046 63.32-24.66 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	23	122z					4.02	4.11
HAU	23	117z					3.86	3.96
RJF	23	128z					3.97	4.07

=> 3.95(0.08)3 => 4.05(0.08)

1990 Oct 31 045015 63.14-24.63 10 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					3.84	3.94
HAU	23	117z					3.75	3.84
RJF	23	128z					3.77	3.86

=> 3.79(0.05)3 => 3.88(0.05)

1990 Oct 31 055217 63.24-24.55 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					3.82	3.92
HAU	23	117z					3.56	3.65

=> 3.69(0.18)2 => 3.79(0.19

1990 Oct 31 062332 63.23-23.93 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	123z					3.71	3.81
HAU	23	118z					3.57	3.66

=> 3.64(0.10)2 => 3.73(0.10)

1990 Oct 31 065857 63.28-24.23 15 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LOR	22	122z					3.84	3.94
HAU	23	118z					3.71	3.80

=> 3.77(0.09)2 => 3.87(0.10)

1990 Oct 31 083937 63.26-24.30 5 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
HAU	23	118z					3.53	3.52

=> 3.53(-)1 => 3.52(-)

1990 Nov 03 142614 63.60-24.00 10 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	20	128z					3.62	3.73
LOR	22	124z					3.54	3.64
HAU	23	119z					3.55	3.64
RJF	23	130z					3.57	3.66

=> 3.57(0.04)4 => 3.67(0.4)

1990 Nov 05 172029 63.09-24.17 10 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	19	127z					3.89	4.00
LOR	22	122z					3.84	3.94
HAU	23	118z					3.55	3.64
RJF	23	129z					3.84	3.93

=> 3.78(0.16)4 => 3.88(0.16)

1990 Dec 29 025743 68.40-18.20 10 **ISC**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
LZH	67	48z					4.92!	4.90

=> 4.92(-) => 4.90(-)

1991 Jan 30 074346 64.38-20.75m 19 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	17	60	17	2.7z			4.53	4.65
UPP	18	86	18	3.1z			4.63	4.75
DBN	18	120z					4.60	4.72
CLL	22	110z					4.55	4.65
GRF	22	116z					4.33	4.43
PRA	23	111z					4.65	4.74
PRU	24	111z					4.74	4.83
PRU	24	111					4.88	4.97
KHC	24	113z					4.68	4.77
KHC	24	113					4.83	4.72
VKA	26	111					4.72	4.80
KRA	26	104z					5.09	5.17
KRA	26	104					5.12	5.20
LRG	26	131z					4.09	4.17
ALQ	57	283z					5.11	5.11
WMQ	59	54z					4.66	4.65
BJI	71	34z					4.78	4.75
TIY	72	37z					4.78	4.75

=> 4.71(0.26)18 => 4.77(0.24)

1992 Apr 25 064845 64.65-17.39 9 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	18	142z					3.86	3.98
BNS	19	125z					4.92	5.03
MOX	21	119z					4.70	4.80
MOX	21	119					4.67	4.77
CLL	21	116z					4.65	4.75
LOR	21	136z					4.39	4.49
HAU	21	131z					4.11	4.21
GRF	21	121z					4.55	4.66
RJF	22	142z					3.81	3.91
PRA	22	116z					4.64	4.74
PRU	22	116z					4.68	4.78
PRU	22	116					4.74	4.84
KHC	23	118z					4.53	4.62

KHC	23	118	4.63	4.72
OBN	28	84z	4.70	4.77
OBN	28	84	4.78	4.85
GTA	65	49	4.93	4.91
GRA	65	49z	4.94	4.92
LZH	70	48	4.97	4.94
LZH	70	48z	4.75	4.72

=> 4.60(0.33)20 => 4.67(0.30)20

1992 Sep 26 054552 64.66-17.60 9 **ENG**

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	61	15	7.9z			4.99	5.13
UPP	17	90	20	6.8z			4.87	4.99
KEV	18	54z					5.11	5.23
FLN	18	142z					4.48	4.61
BNS	19	125z					5.42	5.53
NUR	20	83z					4.99	5.11
MOX	21	119z					5.26	5.36
MOX	21	119					5.33	5.43
CLL	21	116z					5.27	5.37
LOR	21	136z					5.35	5.45
HAU	21	131z					4.98	5.08
GRF	21	121z					5.07	5.17
RJF	22	142z					5.16	5.26
PRA	22	116z					5.33	5.43
PRU	22	116z					5.41	5.51
PRU	22	116					5.31	5.41
PUL	22	80z					5.06	5.16
PUL	22	80					4.99	5.09
WET	22	119z					5.34	5.44
FUR	23	123z					5.37	5.46
KHC	23	118z					5.36	5.45
KHC	23	118					5.22	5.31
WAR	23	104z					4.77	4.86
OJC	24	109z					5.12	5.21
MNK	25	94z					5.04	5.12
MNK	25	94					5.22	5.30
SPC	25	110					5.10	5.18
LVV	26	104z					5.31	5.39
LVV	26	104					5.28	5.36
UZH	27	109z					5.19	5.27
UZH	27	109					5.41	5.49
OBN	28	84z					5.33	5.40
OBN	28	84					5.33	5.40
MOS	28	82z					5.20	5.27
MOS	28	82					5.23	5.30
KIS	31	103z					5.14	5.20
KIS	31	103					5.20	5.26
SIM	34	100z					5.06	5.11
SIM	34	100					5.25	5.30
ANN	36	97z					5.31	5.36
ANN	36	97					5.28	5.33

ARU	36	66z	5.53	5.58
ARU	36	66	5.51	5.56
NRI	37	35z	5.68	5.72
NRI	37	35	5.28	5.32
SVE	37	64z	5.57	5.61
SVE	37	64	5.49	5.53
RSN	37	265z	5.01	5.06
HRV	37	260z	5.27	5.32
SOC	38	96z	5.25	5.29
SOC	38	96	5.09	5.13
PYA	39	92z	5.38	5.42
PYA	39	92	5.34	5.38
MTA	42	92z	4.76	4.79
MTA	42	92	5.13	5.16
MAK	42	89z	5.41	5.44
MAK	42	89	5.51	5.54
TIK	42	15z	5.03	5.06
MCW	43	266z	4.99	5.02
BAK	45	89z	5.74	5.76
CEH	46	262z	4.85	4.87
ILT	47	350z	5.28	5.30
IKT	47	350	5.21	5.23
PMR	49	322z	5.43	5.44
FVM	49	274z	5.43	5.44
SIT	50	321z	5.31	5.32
RSS	50	290z	5.14	5.15
ASH	51	83z	5.63	5.64
ASH	51	83	5.65	5.66
YAK	51	19z	5.18	5.19
YAK	51	19	5.26	5.27
UER	53	47z	5.03	5.03
UER	53	47	5.61	5.61
FRU	53	67z	5.52	5.52
FRU	53	67	5.61	5.61
MIA	53	275z	5.42	5.42
GOL	54	288z	5.63	5.63
IRK	55	40z	5.47	5.47
IRK	55	40	5.37	5.37
MGD	55	7z	5.03	5.03
MGD	55	7	5.22	5.22
ZAK	56	41z	5.29	5.28
ZAK	56	41	5.38	5.37
KSH	57	68	5.53	5.52
KSH	57	68z	5.63	5.62
SDN	57	336z	5.12	5.11
WMQ	57	56z	5.46	5.45
WMQ	57	56	5.64	5.63
CIT	58	33z	5.66	5.65
ALQ	59	286z	5.66	5.65
WDC	60	302z	5.38	5.37
TPN	61	295z	5.65	5.64
SMY	63	352z	5.39	5.38
TUC	63	288z	5.58	5.57

ISA	63	296z					5.81	5.80
GTA	65	49z					5.72	5.70
GTA	65	49					5.77	5.75
ETO	67	41					5.74	5.72
HHC	68	40					5.42	5.40
HHC	68	40z					5.60	5.58
CN2	68	28					5.34	5.32
CN2	68	28z					5.54	5.52
MDJ	68	25z					5.34	5.32
BJI	70	36					5.63	5.60
ENY	70	30					5.28	5.25
ENY	70	30z					5.27	5.24
LZH	70	48					5.53	5.50
TIY	71	40					5.74	5.71
TIY	71	40z					5.60	5.57
LSA	71	61					5.23	5.20
LSA	71	61z					5.25	5.22
DL2	72	32					5.88	5.85
DL2	72	32z					5.48	5.45
XAN	73	44					5.54	5.51
XAN	73	44z					5.58	5.55
TIA	73	37					5.56	5.53
TIA	73	37z					5.78	5.75
CD2	74	50					5.61	5.58
CD2	74	50z					5.57	5.54
WHN	78	41					5.66	5.62
WHN	78	41z					5.72	5.68
KMI	79	53z					5.23	5.19
GYA	79	49					5.69	5.65
GYA	79	49z					5.35	5.31
QIZ	87	49					5.71	5.66
HON	89	324z					5.44	5.39
ZOB	89	228z					5.04	4.99
LPB	90	228z					5.39	5.34

=> 5.36(0.25)128 => 5.38(0.23)

1992 Dec 27 122321 64.00-21.20m 3 ISC

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
FLN	19	133z					3.70	3.81
LOR	22	128z					3.64	3.74
HAU	22	123z					3.49	3.59
RFJ	23	134z					3.69	3.78

=> 3.63(0.10)4 => 3.73(0.10)

1993 Jun 22 123349 64.71-17.30 6 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
KIR	15	61	14	3.7z			4.69	4.83
UPP	17	90	23	3.5z			4.51	4.63
DBN	17	127z					4.25	4.37
FLN	18	142z					4.60	4.72
BNS	19	125z					5.04	5.15

MOX	21	119z	4.80	4.90
CLL	21	116z	4.80	4.90
LOR	21	136z	4.85	4.95
HAU	21	131z	4.49	4.59
GRF	21	121z	4.70	4.80
BRG	21	115	4.89	4.99
BRG	21	114z	4.97	5.07
RJF	22	143z	4.55	4.65
PRA	22	116z	4.89	4.99
PUL	22	80z	4.65	4.75
PUL	22	80	4.62	4.72
WET	22	120z	4.76	4.86
FUR	23	123z	5.00	5.09
RAC	24	111z	4.71	4.80
MNK	25	94z	4.64	4.72
UZH	26	108z	4.71	4.79
UZH	26	108	4.76	4.84
OBN	28	84z	4.77	4.84
OBN	28	84	4.79	4.86
MOS	28	82z	4.90	4.97
MOS	28	82	5.13	5.20
KIS	30	103z	4.76	4.82
KIS	30	103	4.69	4.75
SKO	32	117z	4.74	4.80
ANN	36	97z	4.82	4.87
ANN	36	97	4.80	4.85
ARU	36	66z	5.17	5.22
ARU	36	66	5.13	5.18
NRI	37	35z	4.84	4.88
NRI	37	35	5.10	5.14
SVE	37	65z	5.24	5.28
SVE	37	65	5.10	5.14
SOC	38	96z	4.95	4.99
SOC	38	96	4.77	4.81
KIV	39	93z	4.90	4.94
PYA	39	92z	4.94	4.98
PYA	39	92	5.04	5.08
GRO	41	90z	5.07	5.10
GRO	41	90	5.19	5.22
MTA	42	93z	4.88	4.91
SHE	44	90z	4.78	4.80
SHE	44	90	5.01	5.03
BAK	45	89z	5.34	5.36
BAK	45	89	5.57	5.59
ILT	47	351z	5.00	5.02
ILT	47	351	4.88	4.90
ELT	49	51z	4.80	4.81
PMR	49	332z	4.81	4.82
YAK	51	19z	4.62	4.63
YAK	51	19	4.64	4.65
FRU	53	67z	5.16	5.16
MGD	55	7z	4.69	4.69
MGD	55	7	4.62	4.62

KSH	56	68					5.26	5.24
KSH	56	68z					5.34	5.34
WMQ	57	56					5.21	5.20
WMQ	57	56z					5.17	5.16
LIC	59	166z					4.84	4.82
WDC	60	302z					4.75	4.74
CMB	62	299z					4.87	4.86
BKS	62	300z					5.02	5.01
GTA	65	49					4.93	4.92
GTA	65	49z					5.36	5.34
BTO	67	41					5.28	5.26
YSS	68	15z					4.74	4.72
YSS	68	15					4.96	4.94
CN2	68	28					5.02	5.00
CN2	68	28z					5.04	5.04
BJI	69	36					5.37	5.35
BJI	69	36z					5.36	5.34
SNY	70	30z					5.00	4.97
LZH	70	48					5.14	5.11
LZH	70	48z					5.02	4.99
TIY	71	40					5.34	5.31
TIY	71	40z					5.44	5.41
XAN	73	44					5.23	5.20
XAN	73	44z					5.27	5.24
CD2	74	50z					5.08	5.05
NJ2	78	37z					4.96	4.92
SSE	79	35					5.43	5.39
SSE	79	35z					5.19	5.15
GYA	79	49z					4.92	4.88
ZOB	89	228z					4.64	4.59

=> 4.93(0.26)88 => 4.96(0.25)88

1994 Feb 08 032758 66.47-1925 17 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DAG	10	1z					4.98	5.16
KIR	15	67z	12	12z			5.25	5.39
UPP	18	95z	14	7.4z			5.11	5.23
DBN	19	128z					4.89	5.00
NUR	20	86z					5.06	5.17
BNS	20	127z					5.62	5.73
MOX	22	121z					5.09	5.19
LOR	23	137z					5.25	5.34
PUL	23	83z					5.63	5.72
PUL	23	83					5.55	5.64
HAU	23	132z					4.89	4.98
BRG	23	117					5.43	5.52
GRF	23	122z					5.22	5.31
PRA	24	117z					5.73	5.82
PRU	24	117z					5.34	5.43
PRU	24	117					5.51	5.60
WET	24	121z					5.45	5.54
RJF	24	142z					4.97	5.06

FUR	24	124z	5.42	5.51
RAC	25	113z	5.11	5.19
MNK	26	96z	5.44	5.52
MNK	26	96	5.58	5.66
LVV	27	106z	5.24	5.32
LVV	27	106	5.54	5.62
UZH	28	119	5.60	5.67
MOS	28	84z	5.52	5.59
MOS	28	84	5.52	5.59
KIS	32	104z	5.34	5.40
KIS	32	104	5.50	5.56
CBM	32	257z	5.07	5.13
LBN	36	258z	5.06	5.11
ARU	36	67z	5.86	5.91
ARU	36	67	5.53	5.58
SVE	36	66z	5.96	6.01
SVE	36	66	5.70	5.75
ANN	37	98z	5.39	5.43
ANN	37	98	5.34	5.38
LSC	38	257z	5.44	5.48
PYA	40	93z	5.41	5.44
PYA	40	93	5.44	5.47
YSN	40	263z	5.44	5.47
GRO	41	91z	5.98	6.01
GRO	41	91	6.15	6.18
MCW	43	262z	5.39	5.42
CEH	46	259z	4.69	4.71
PMR	47	330z	5.17	5.19
SLM	48	271z	5.32	5.33
SIT	48	319z	5.19	5.20
FVM	48	271z	5.77	5.78
GOG	50	261z	5.36	5.37
NEW	50	300z	5.25	5.26
ASH	51	83	5.92	5.93
OXF	51	268z	5.18	5.19
MIA	53	272z	5.56	5.56
GLD	53	285z	5.67	5.67
WMO	55	276z	5.73	5.73
SDN	55	334z	5.09	5.09
DUG	55	292z	5.42	5.42
KSH	56	68	5.87	5.87
KSH	56	68z	5.81	5.81
WMQ	57	56	5.44	5.44
WMQ	57	56z	5.88	5.88
ALQ	57	283z	5.71	5.71
WDC	58	300z	5.23	5.22
TPN	59	293z	5.34	5.33
CMB	60	297z	5.15	5.14
SMY	61	351z	5.37	5.36
PET	61	2z	5.12	5.11
ISA	61	294z	5.38	5.37
TUC	61	286z	5.56	5.55
SAO	61	297z	5.20	5.19

GTA	64	49	5.47	5.45
GTA	64	49z	6.00	5.98
BTO	66	40	5.42	5.40
HHC	66	39	5.40	5.38
HHC	66	39	5.53	5.31
MDJ	67	24z	5.20	5.18
CN2	67	27	5.27	5.25
CN2	67	27z	5.13	5.11
SNY	68	29z	5.12	5.10
BJI	68	35	5.76	5.74
LZH	69	47	5.63	5.61
LZH	69	47z	5.63	5.61
TIY	70	39	5.63	5.60
TIY	70	39z	5.84	5.81
LSA	71	60	5.54	5.51
LSA	71	60z	5.97	5.94
XAN	72	43	5.66	5.63
XAN	72	43z	5.72	5.69
TIA	72	36	5.49	5.46
TIA	72	36z	5.54	5.41
CD2	74	49	5.56	5.53
CD2	74	49z	5.60	5.57
MAT	76	19z	5.16	5.13
WHN	77	40	5.48	5.44
WHN	77	40z	5.39	5.35
SSE	78	34	5.45	5.41
SSE	78	34z	5.29	5.25
GYA	79	48	5.80	5.76
GYA	79	48z	5.02	4.98
KMI	79	52	5.42	5.38
KMI	79	52z	5.43	5.39
HON	87	322z	5.42	5.37

=> 5.44(0.28)103 => 5.46(0.27)

1994 May 05 051452 64.52-17.52 9 ENG

St	*D*	*Az*	*T1*	*A1*	*T2*	*A2*	*Ms*	*Msc*
DAG	12	359					5.05	5.21
DAG	12	359z					4.95	5.11
KIR	15	61	16	5.5z			4.79	4.93
UPP	17	90	18	6.1			4.87	4.99
DBN	17	126z					4.75	4.87
COP	17	107z					4.61	4.73
BNS	19	125z					5.48	5.59
MOX	21	119z					5.18	5.28
GRF	21	121z					4.96	5.06
BRG	21	115					5.28	5.38
BRG	21	115z					5.40	5.50
PRA	22	116z					4.80	4.90
PRU	22	116z					5.26	5.36
PRU	22	116					5.36	5.46
PUL	22	80z					4.92	5.02
PUL	22	80					5.04	5.14

KHC	23	118z	5.13	5.22
KHC	23	118	5.04	5.13
MNK	25	94z	5.14	5.22
LJU	26	121	5.26	5.34
UZH	26	108z	5.04	5.12
UZH	26	108	5.20	5.28
OBN	28	84z	5.11	5.18
OBN	28	84	4.69	4.76
MOS	28	82z	5.18	5.25
MOS	28	82	5.09	5.16
KIS	30	103	5.14	5.20
CBM	32	262z	5.00	5.06
SIM	34	100z	5.25	5.30
ARU	36	66z	5.33	5.38
ARU	36	66	5.20	5.25
LBN	36	263z	5.09	5.15
SVE	37	64z	5.41	5.44
SVE	37	64	5.27	5.31
HRV	37	260z	5.08	5.12
SOC	38	95z	5.19	5.23
SOC	38	95	5.14	5.18
LST	39	261z	5.09	5.13
KIV	39	92z	5.03	5.07
PYA	39	92z	5.29	5.33
PYA	39	92	5.42	5.46
YKA	39	313z	5.25	5.29
BIN	40	264z	5.03	5.06
YSN	40	267z	5.06	5.09
GRO	41	90z	5.58	5.61
GRO	41	90	5.78	5.81
MAT	42	92	4.96	4.99
MAK	42	89z	5.21	5.24
MAK	42	89	5.66	5.69
BAK	45	89z	5.59	5.61
BAK	45	89	5.87	5.89
ILT	47	350z	5.37	5.39
ILT	47	350	5.11	5.13
KAT	49	84z	5.16	5.17
KAT	49	84	5.10	5.11
PMR	49	332z	5.19	5.20
SIT	50	321z	5.32	5.33
GOG	50	265z	5.18	5.19
ASH	51	83z	5.50	5.51
ASH	51	83	5.57	5.58
MIA	54	275z	5.17	5.17
GLD	54	288z	5.51	5.51
GOL	52	288z	5.07	5.07
IRK	55	40z	5.29	5.29
IRK	55	40	5.46	5.46
WMO	56	279z	5.54	5.54
KSH	57	68	5.39	5.39
KSH	57	68z	5.48	5.48
DUG	57	294z	5.49	5.49

```
SDN 57 336z                        5.30  5.30
WMQ 57  56                         5.35  5.35
WMQ 57  56z                        5.30  5.30
ALQ 58 286z                        5.50  5.49
LIK 59 165z                        4.96  4.95
YBH 59 303z                        5.14  5.13
WDC 60 302z                        5.38  5.37
ORV 61 301z                        5.78  5.77
CMB 62 299z                        5.47  5.46
TUC 63 288z                        5.35  5.34
SMY 63 352z                        5.31  5.30
PET 63   3z                        4.98  4.97
ISA 63 296z                        5.68  5.67
SAO 63 299z                        5.61  5.60
GTA 65  49                         5.09  5.07
GTA 65  49z                        5.52  5.50
BTO 67  41                         5.31  5.29
HHC 68  40                         5.23  5.21
HHC 68  40z                        5.34  5.32
CN2 68  28z                        5.10  5.08
BJI 70  36                         5.53  5.50
BJI 70  36z                        5.58  5.55
SNY 70  30z                        5.21  5.18
LZH 70  48                         5.28  5.25
LZH 70  48z                        5.19  5.16
TIY 71  40z                        5.41  5.28
TIY 71  40                         5.55  5.52
XAN 73  44                         5.55  5.52
XAN 73  44z                        5.39  5.36
NJ2 78  37                         5.48  5.44
NJ2 78  37z                        5.33  5.29
SSE 79  35                         5.42  5.38
SSE 79  35z                        5.43  5.39
KMI 79  53                         5.19  5.15
KMI 79  53z                        5.14  5.10
GYA 80  49z                        5.19  5.15
HON 89 324z                        5.08  5.03
                                => 5.26(0.24)106 => 5.28(0.22)
```

```
1995 Dec 11  052248  64.59-17.74  10                         ENG
 St     D Az     T1   A1     T2   A2    Ms     Msc
FLN   18 141z   18   1.4               4.27   4.39
MOX   21 118z   19   2.7               4.65   4.75
LOR   21 135z   16   2.4               4.67   4.77
HAU   21 130z   17   0.7               4.11   4.21
GRF   21 120z   21   0.7               4.02   4.12
BRG   21 114    26   0.5    26   0.6  3.97   4.07
PRU   22 115z   12   1.2               4.53   4.63
OBN   28  84z   14   0.5               4.06   4.33
KIS   30 102    15   0.6    17   0.6  4.47   4.74
```

```
BRVK 43   62    18  0.1   16   0.1 3.93   3.96
BJI  69   36z   20  0.3            4.53   4.50
LZH  70   47z   22  0.3            4.50   4.47
                               =>  4.33(0.27)12 => 4.39(0.26)12
```

NOTES

A key to the worksheets in Part III

St	Station code
D	Geocentric epicentral distance of station in degrees
Az	Azimuth of station
A1 A2	Maximum horizontal ground displacements
T1 T2	Corresponding periods in seconds
z	Indicates A and T taken from vertical component
Ms	Event magnitude from Prague formula
Msc	Event magnitude corrected for distance

(Event M) (Standard deviation) (number of stations reporting)
=>Ms (Prague) => Msc (Prague, corrected for D)