A STUDY OF THE BASIC COMPONENTS OF SEISMIC HAZARD ASSESSMENT FOR THE SOUTH AUSTRALIAN AREA

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Declaration

I hereby declare that to the best of my knowledge and belief this thesis contains no material previously published or written by another person except where due reference is made in the text of the thesis. It also contains no material which has been accepted for the award of any other degree or diploma in any university.

D.G. Rossiter

TABLE OF CONTENTS

Summary

1. Introduction

    1.1. Preamble

    1.2 The seismic design process

        1.2.1 Quasi static design

        1.2.2 Dynamic methods

        1.2.3 Comparison of methods

2. Seismic risk methods

    2.1 Seismic hazard assessment

    2.2 The components of a seismic hazard assessment

3. Parameters used in risk assessment

    3.1 The Spatial distribution of seismic events, sources

    3.2 Rate of recurrence of events

        3.2.1 Average numbers method

        3.2.2 Maximum likelihood method

        3.2.3 Extreme value method

        3.2.4 Seismic moment method

        3.2.5 Discussion of recurrence methods

        3.2.6 Maximum possible magnitude

    3.3 Attenuation relationship

4. Seismicity in South Australia

4.1 South Australian Seismicity

4.2 Spatial distribution of events in South Australia

4.3 Recurrence relationships in South Australia

4.4 Attenuation relationships in South Australia

5. Risk assessment

5.1 Seismic risk program

5.2 Seismic risk analysis at higher risk site

5.3 Seismic risk analysis at lower risk site

5.4 Commentary on risk analyses

6. Comparison with existing analyses

6.1 Existing seismic risk analyses

6.2 Comparison of analyses

7. Conclusions

References

Appendix A MM Intensity Scale

Appendix B Recorded data and seismometer network

Appendix C Risk analysis results and effects of varying parameters

Appendix D Risk analysis by an historical record method for Adelaide

Appendix E Source listing of program ROSIE

Appendix F Attenuation equations

Summary

This thesis examines briefly seismic hazard assessment procedures as used in Australia and overseas. The three base components of any analysis are examined, viz (i) spatial distribution of events within the source, (ii) recurrence of events within the source and (iii) attenuation of effects from the source. The base components are then related specifically to South Australian conditions.

It is established that though there are uncertainties in the spatial distribution of events and their recurrence these problems are common to all seismic areas worldwide and these matters are receiving research attention overseas which can be applied here. The passage of time will enable better precision in defining spatial distribution and recurrence as data are quite well recorded at present. The third component is examined and it is established that the best use is being made of scant available data at present. However attenuation relationships should not be "borrowed" as presently done from overseas areas without verification and unless strong motion instruments are distributed widely and not grouped at the city centre as at present, little future advance can be anticipated in the accuracy of seismic hazard assessment, due to the weakness inherent in attenuation assumptions.

CHAPTER 1 - INTRODUCTION

1.1 Preamble

In areas of known seismic activity it is essential that structures of all types can be designed in such a manner as to make the risk and consequences of their failure from seismic loading effects no greater than those which society is already prepared to tolerate with respect to other loadings such as wind. Much research has been done overseas that has led to development of techniques for seismic hazard assessment and seismic design. Most of these techniques can be applied to Australian structures but, before they can be used, some basic parameters have to be established. The characteristics of Australian seismic activity need to be examined in order to perform seismic hazard analyses and hence assess relevant levels of the widely established structural loading parameters of acceleration, velocity, displacement and relevant frequency ranges.

Initially a brief outline of the available seismic design processes for structures is discussed to show why the assessed hazard is a necessary part of the design process. Then the three basic components of a seismic hazard assessment are examined. They are:

(i) spatial distribution of events

(ii) recurrence of events within the source

(iii) attenuation of effects from the source

Examination of each component is made in conjunction with a literature survey in relation to recent overseas research and then this work is related to Australian conditions and specifically South Australian conditions. It is demonstrated that some of these basic components and subsidiary parameters which make up each component have little effect on the ultimate assessed hazard. Other components are shown to be more sensitive and affect the assessed risk more radically.

1.2 The Seismic Design Process

Once the likely loadings have been established (the zoning process) there are two basic design approaches possible

(a) Quasi-static design

(b) Dynamic design

1.2.1 Quasi-static Design

Most seismic structural design codes use this approach (for example AS 2121-1979). The general technique is to calculate the seismic loading parameters of acceleration velocity and displacement at an acceptable level of risk and then to zone the location. As the zones are discrete e.g. Zone 1, Zone 2, etc., and incorporate ranges of loadings at a given risk accuracy of the original assessment is not paramount. The seismic loadings are then taken as an equivalent static loading for the zone. These static loads are applied to the structure and distributed in such a way as to try to emulate the effects that would occur under the equivalent dynamic loading.

Furthermore, in the widely used codified approach, these loads are reduced to simplify analysis so that calculations are performed at elastic stress levels and the ductility characteristics of the structural type are taken into account. This means that the designer has inherently assumed by using a codified approach that:

(i) the period of oscillation of his structure is within the range that the code envisaged in its drafting.

(ii) the mass distribution of his structure is within the range that the code envisaged in its drafting.

(iii) the stiffness distribution of his structure is within the range that the code has envisaged in its drafting.

(iv) the ductility (and the detailing which is essential for adequate ductility) of his structure is within the range that the code envisaged in its drafting.

(v) there is a risk of some damage to the structure (most seismic codes accept local damage will occur but total collapse of the structure will not).

The designer is then left with little scope for variation in the layout of his buildings. Effectively he must have a building that is the "uniform shear beam" envisaged by the codified approach in which mass and stiffness are uniformly distributed. This means a structure without podia, machinery floors, asymmetrical elevations, asymmetrical plan, etc. or a structure with some or all of these features that may be at greater risk than that expected when a seismic event occurs.

1.2.2 Dynamic Design

This design technique can be performed in two basic ways (i) by the response spectrum technique or (ii) by taking an existing (hopefully local) actual recorded ground motion and normalising it to the established seismic loading parameters.

Both methods can be performed in a variety of ways both elastically and plastically and enable the designer to account more accurately for non uniform mass distribution, non uniform stiffness distribution and asymmetry. The designer is also able to stipulate stress levels, find ductility requirements and deflections. Assumptions are made in both methods for elastoplastic design,the latter method probably gives the best indications of how the structure actually functions under seismic loading.

1.2.3 Comparison of Methods

Hence the quasi static approach in codified form allows a relatively simple design technique to be used for "uniform shear beam" structures. Because of a series of assumptions this does not require a precise analysis of the seismic loading other than to establish a zoning requirement.

However should the structure require more accurate assessment of its design loadings because it is not a "uniform shear beam" or because it is a structure of unusual importance, dynamic analysis is required. This type of analysis requires a more precise analysis of seismic hazard in order to establish the seismic design loading or loadings. Often important structures, such as nuclear power plants, are designed dynamically to two levels of seismic loading. Acceptable risks are established for the basis of continuing operation of plant (called Operating Basis Earthquake: OBE) and for safe shut down (called Safe Shutdown Earthquake:SSE). This enables the structure to be more economically designed so that there are two associated levels of stressing:* no damage for OBE and verging on collapse with some damage for SSE. This is not possible with the traditional quasi static approach except by introducing arbitrary importance factors (ATC 3: Tentative Provisions for the Development of Seismic Regulations for Buildings, attempts to negate this disadvantage). Therefore in order to design accurately (or as accurately as can practically be done) dynamic design** needs to be performed and hence seismic loadings need to be assessed accurately. The situation at present (1982) in Australia is that seismic zones have been assessed but they have been hampered by the lack of knowledge of the parameters that are characteristic of Australia.

*Stress levels referred to are generally critical ones i.e. with no margin of safety.

**Dynamic design utilises linear or non linear time dependent loadings and quantifies structural response.

The parameters that have been used to date have generally been those of California where local Australian ones are not known. The analogy can be drawn with soil mechanics: if one were to use strengths derived from soil in California for design work in Australia there would be considerable concern.

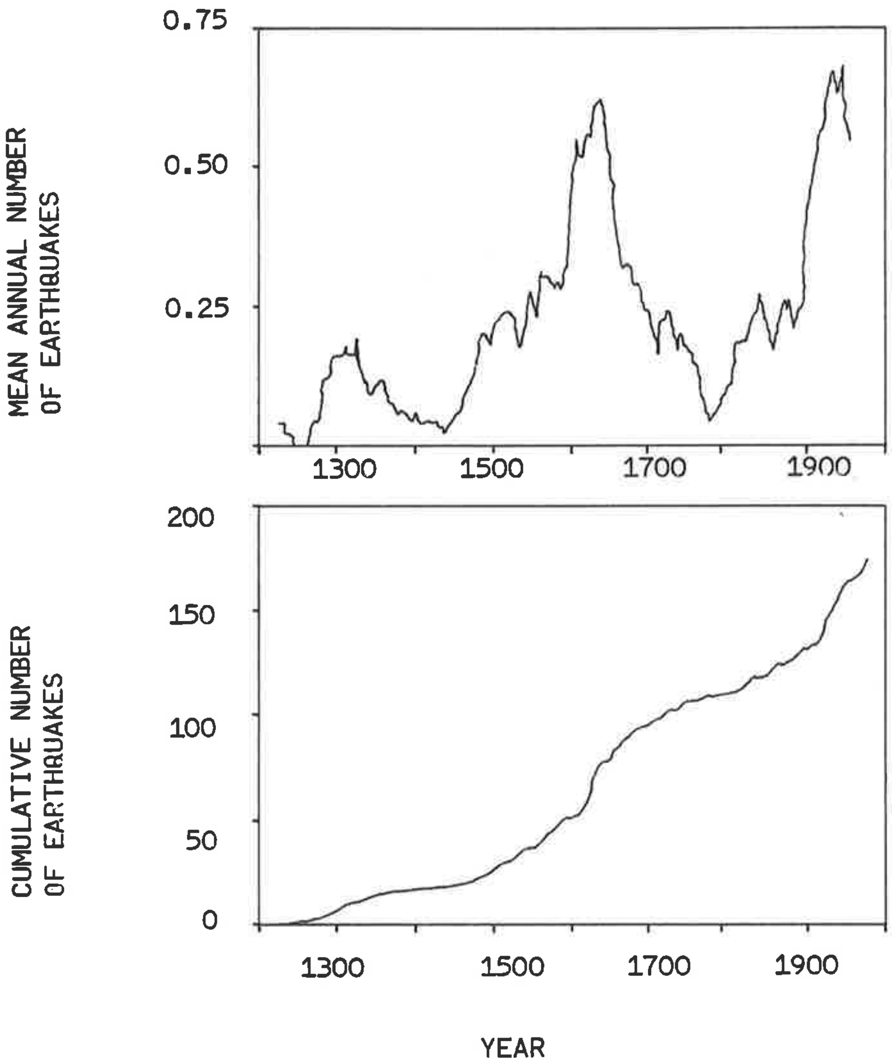
Let us therefore look at the components of a seismic hazard assessment.

CHAPTER 2

2.1 Seismic Hazard Assessment

Throughout the world much scientific research effort has been directed towards the ideal of earthquake prediction. However at present there is no proven reliable scientific technique that can be used to predict events. From the engineers viewpoint the time frame for which prediction of events would be useful would generally be for 25-100 years, the typical economic life of structures today. Much of the scientific research into prediction is being directed towards shorter term occurrence of events to enable communities to be aware that events are imminent and prepare accordingly.

Until prediction methods are established seismic hazard assessment will probably continue to be done using historical data and extrapolating statistical predictions into the future. It is well known that there are considerable variations in seismic activity with time and hence this throws considerable doubt on the use of historical data for forecasting events. Ambraseys (1971) has been examining historical records of earthquake events in the Eastern Mediterranean which occurred in the last 2000 years. He observes that many events have not been properly recorded in modern day catalogues and states "the total number of all earthquakes, large and small, identified so far for the period AD10 to 1699, is just over 3,000 (within the area he was cataloguing), or about twenty times the number of genuine earthquakes listed for the same period in modern catalogues." Equally he notes that some single events which have been recorded and described by different literary sources have been listed as two or more events in modern catalogues. However despite the obvious inadequacies of the records and his need to spend many years re-examining the data at source (by 1971 he had spent 10 years) he notes that there is some temporal variation in the seismicity. McGuire and Barnhard (1981) have been studying the earthquake records of China from 1350 to 1949 and observe changes in the rates of seismic activity in that period to be by a factor of ten. Using the information available (see Figure 2.1) they took 50 year periods of data and used that data to predict the following 50 years of activity such as might be done by a present day seismic hazard assessor. They found that providing the maximum possible earthquake size was taken from the entire record and not the data window only and also that the activity was predictable, a reasonable estimate of future activity could be made. The latter qualification is more difficult to assess than the former and can only currently be done on a basis similar to that used for examination of trends, by stock exchange investors. If future activity cannot be predicted in some way, e.g. by using trends, McGuire and Barnhard found that the stationary activity model gave less accurate but generally conservative assessment of seismic hazard. They found that when they looked at the records available in the Central and Eastern United States for the last 180 years the rate of release of seismic strain had been constant and also that geological evidence over the last 15 centuries along the



FROM MCGUIRE AND BARNHARD (1981)

FIGURE 2.1

San Andreas fault showed no temporal trend. They therefore suggested that seismic activity was either stationary or of such a long period that it can be treated as stationary for the purpose of seismic hazard assessment in the United States.

2.2 The Components of a Seismic Hazard Assessment

There are three basic components of a seismic hazard assessment

(i) the spatial distribution of the seismic events

(ii) the rate of occurrence and magnitude of the events.

(iii) attenuation relationships which are a measure of the intensity of the effects from an event and the rate at which they attenuate with distance from the event.

This is the basis of the method of most seismic risk assessment procedures e.g. Cornell (1968), though some methods purport only to assess the magnitude of an event at some specified return period, (e.g. Campbell et al 1979), and hence require no attenuation relationship.

CHAPTER 3 PARAMETERS USED IN RISK ASSESSMENT

3.1 The Spatial Distribution of Seismic Events

For the purposes of the seismic hazard assessment it is necessary to assess the type of event source. These can be broadly point sources, line sources, area sources or volume sources, see Figure 3.1. These source types, excepting point sources, can be categorised also as uniform and non uniform. For example an area source may have more activity at its boundaries than in the centre and is hence a non uniform activity area. The site at which effects are to be measured may be affected by several different types of source which compound the hazard at that site. Also in the case of some types of source, for example the line source, it may be necessary to use judgement as to whether a line source alone describes the activity correctly. Historic data may indicate quite clearly a close correlation between a fault and activity. This is well known in the case of the San Andreas fault in California where major events appear to occur along the line of the main fault. However close examination of data shows that several events of considerable size have occurred on splinter faults previously believed to be quiescent and away from the main fault e.g. San Fernando 1971. These faults have been shown to be merely dormant during the period of historic recordings. It is probably wise therefore to assume perhaps in the case of such faults a main linear faulting system with an associated area source where recurrence rates for events may be different.

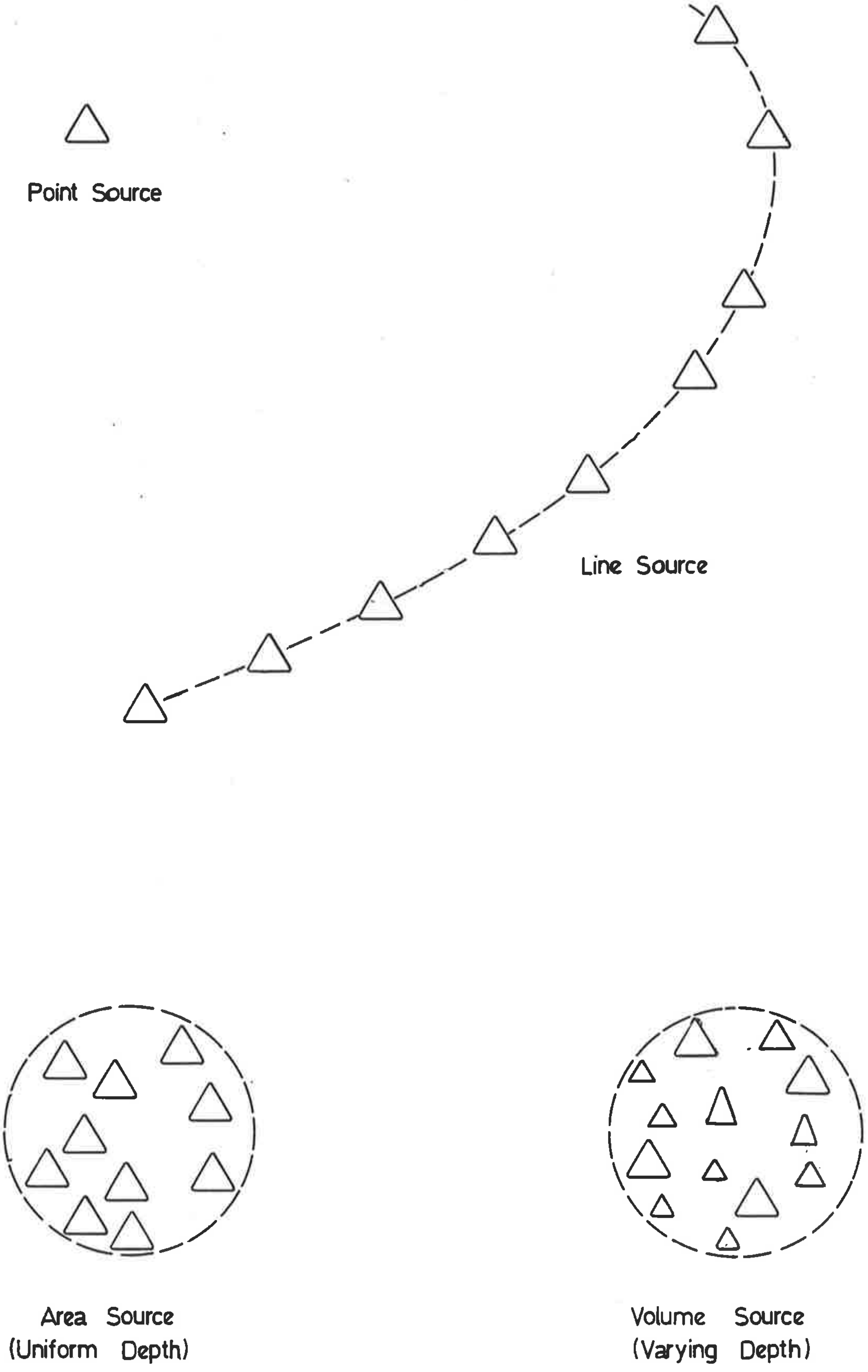


Figure 3·1 Basic Source Types for Seismic Events

Assessment of the sources contributing to the hazard at a site can be very difficult as there may be little knowledge of the geology at the depths at which events are occurring and the larger more damaging events are often infrequent. In South Australia depths are commonly regarded as shallow at around fifteen kilometres and event depths up to seven hundred kilometres are common internationally. The depth of the deepest exploratory hole (as at 1980) ever drilled is only ten and a half kilometres though there are other techniques for assessment of geology that are used. The mechanism that causes the deeper earthquake events is still unclear and there are many theories such as that of phase changes of materials. Shallower earthquake events are generally attributed to some form of faulting action, though volcanic activity (Mount St. Helen, United States 1981) and other sources do contribute to records. The major part of the larger seismic events result from tectonic activity at inter plate boundaries where subduction shearing or accretion are occurring. For the purposes of assessing the seismic hazard it is not essential to know the precise mechanism that is causing the seismic events and observation of the historic activity may give a clear indication of the type of source to be assumed.

When sources are assessed with limited data, often the case in Australia, judgement has to be made on source size from the scant data available.

In terms of spatial distribution it may be necessary to divide an area of activity into areas which are so small that the data sets for each area are too short/small to enable a realistic assessment of recurrence rate and maximum magnitude to be made. McEwin, Underwood and Denham (1976) found this problem when doing seismic hazard assessment using fixed area uniform sources for the whole of seismically active Australia.

3.2 The rate of recurrence of events

This expression commonly known as the recurrence relationship defines the characteristics of magnitude and of frequency of occurrence of events. Generally the assumed relationship is of the form proposed by Gutenberg and Richter (1956).

$$\log\left[\frac{N_c}{T}\right] = a - b\, M_L$$

where N_c is the cumulative number of events in T years equal to or exceeding the Richter magnitude of the event, M_L, and a and b are constants characteristic of the area considered. The constant a is a measure of the activity and b is a measure of the ratio of small events to large events.

In addition, the recurrence relationship has an upper limit and a maximum possible magnitude is often established as a cut off point (see Figure 3.2).

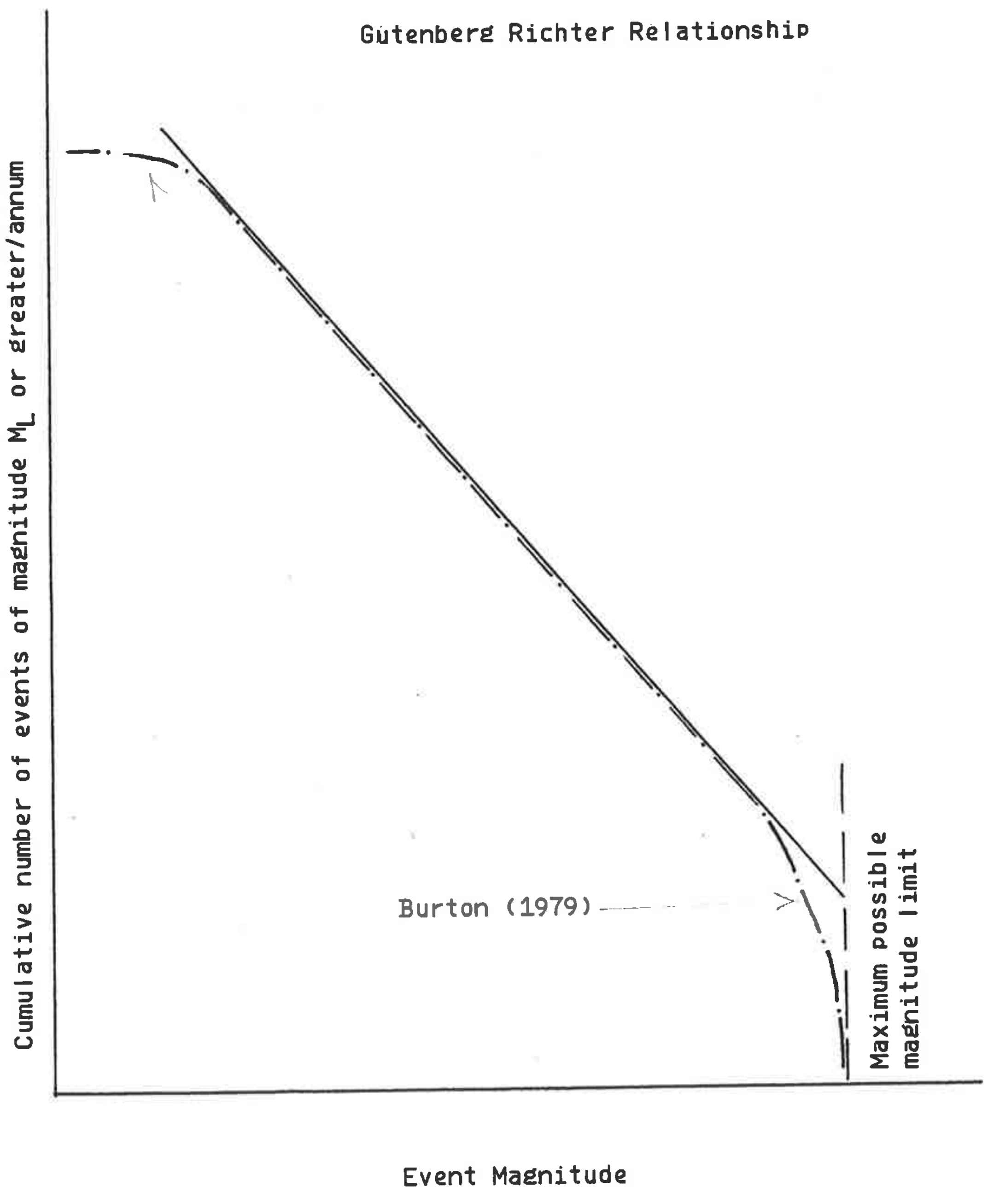


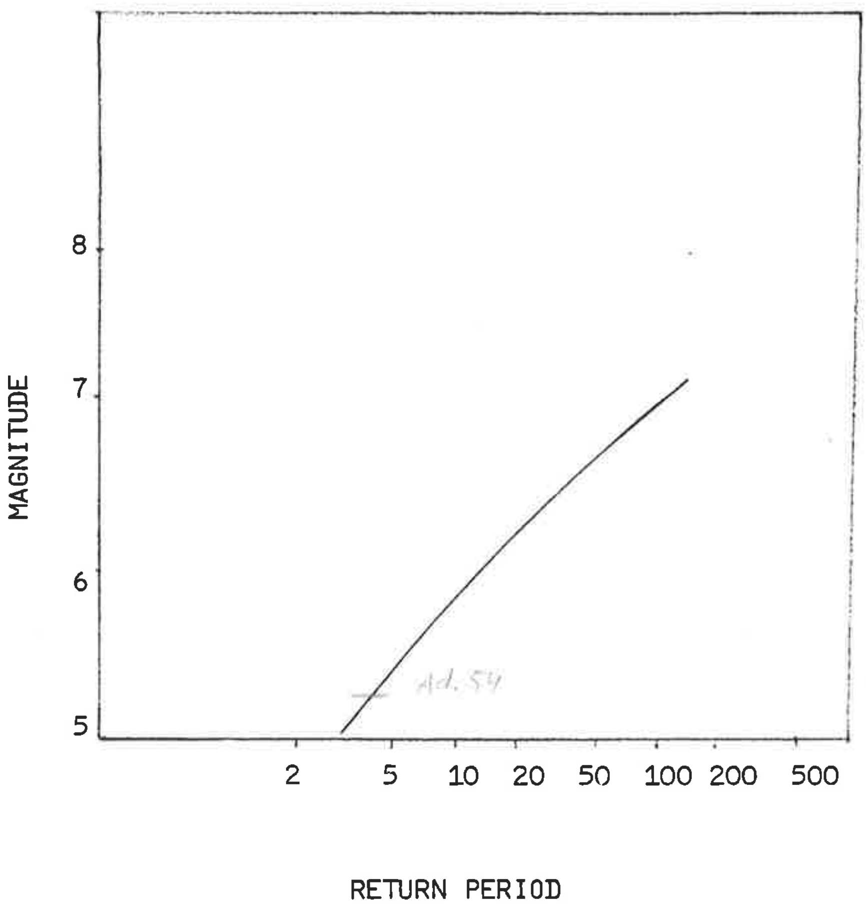
Figure 3.2 Recurrence Relationships

This maximum possible earthquake has a finite value. This finite upper limit is logical as the crust of the earth has a limited strength beyond which it will not continue to absorb energy without some failure occurring. In consequence the maximum possible event varies from region to region as crust properties vary. Though widely used, the Gutenberg-Richter relationship is not always assumed to be entirely correct and Burton (1979) notes that curvature is observable in the upper and lower magnitude ranges.

Yegulalp and Kuo (1974) though primarily examining maximum magnitudes observe that there appears to be curvature of the recurrence relationship for the larger events and the curvature appears to be greatest in the northern and western circum-Pacific belt and least in the oceans and stable continental masses. The relationship shown for Australia (see figure 3.3) is virtually linear and exhibits very little curvature.

Makjanic (1980) has examined the relationship and proposed that the linear relationship of Gutenberg-Richter at larger magnitudes approaching the maximum possible earthquake exhibits some curvature and also at low magnitudes a similar effect occurs (see Fig. 3.2). He proposed a generalized exponential distribution. At the lower end of the magnitude scale this effect is probably of little significance, unless very small events (< Richter Magnitude 2) are used to establish the Gutenberg-Richter line. At the upper end of the scale the occurrence rates of the larger magnitude events are so small that it is difficult to assess

So according to time scale EQ



RECURRENCE RELATIONSHIP BY YEGULALP
AND KUO (1974) FOR AUSTRALIA

FIGURE 3.3

what the curvature might be if records are short such as occurs in Australia. It is therefore suggested that the traditional approach (Gutenberg-Richter relationship and maximum possible earthquake cut off) be used as this would represent an upper bound (conservative) solution in the seismic hazard analysis and agrees closely with the findings of Yegulalp and Kuo noted. It can be also shown that small variations in the value of maximum possible earthquake have little effect relative to other errors on calculated seismic hazard assessments for periods up to 1000 years for South Australian seismicity (see Appendix C). This is because the probability of occurrence of the larger events is quite small (see figure 3.4). Calculation of the recurrence relationship is very much dependent on the quality of data available and its duration. In figure 3.4 the data is plotted from 1966-1979 for a source basin. This data broadly falls into three categories. The category A data is of small magnitude and is subject to errors in recording due to lack of sensitivity of instruments or insufficient coverage of the basin area by instruments. Events may be missed in remote areas of the basin and the theory of Makjanic may apply in this magnitude range as well. The category B data is likely to be recorded quite well by the instruments and though the numbers of such events will be fewer than those in category A the data is likely to be more reliable. The events are big enough to be recorded if they occur in the basin and frequent enough to be recorded in reasonable numbers. The category C data has no problem in being recorded at instruments, except that larger events near to

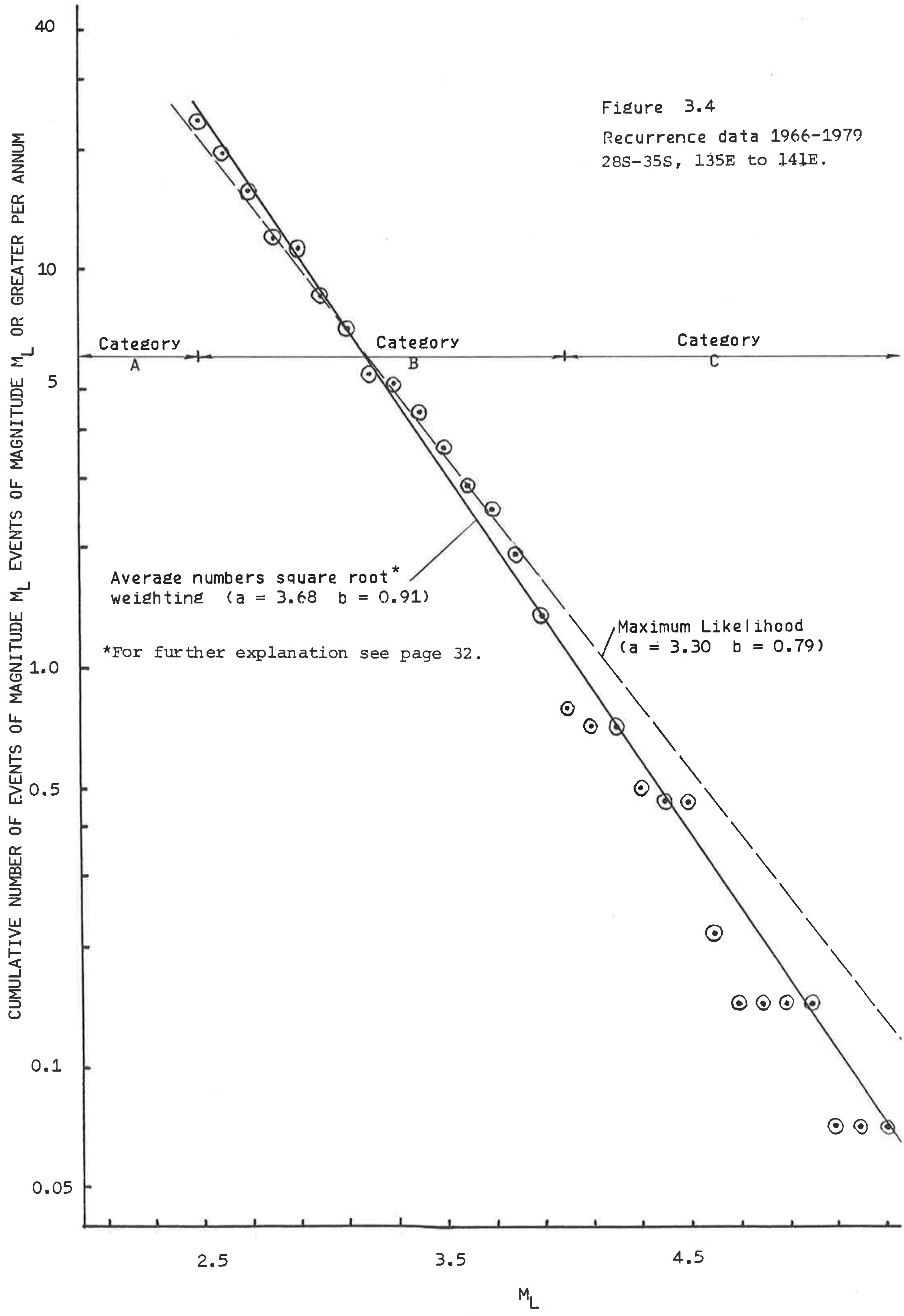


Figure 3.4
Recurrence data 1966-1979
28S-35S, 135E to 141E.
40
10
5
1.0
0.5
0.1
0.05
CUMULATIVE NUMBER OF EVENTS OF MAGNITUDE M_L EVENTS OF MAGNITUDE M_L OR GREATER PER ANNUM
Category A
Category B
Category C
Average numbers square root* weighting (a = 3.68 b = 0.91)
Maximum Likelihood (a = 3.30 b = 0.79)
*For further explanation see page 32.
2.5
3.5
4.5
M_L

instruments may cause problems with overloading, however with short duration* records the numbers of these events may be very small and hence these points can be increasingly inaccurate with larger magnitudes. Three basic techniques are used to fit curves to the data and there is considerable debate as to which method gives the most sensible results. The three techniques are known as (Weichert and Milne (1979))

(a) Average Numbers

(b) Maximum Likelihood

(c) Extreme Value

3.2.1 Average Numbers

In this technique the data of figure 3.4 for example would be fitted to a relationship by a curve fitting technique. Some data at the lower end of the range may be ignored as being poorly recorded due to threshold problems with the instrumentation and then curve fittings done. Unfortunately the most widely used curve fitting system used is a least squares linear regression which is not really suitable for this application. Least squares linear regression assumes that the data points are independent (not possible in a cumulative frequency plot) and have equal errors (the numbers of records attributing to each point vary widely) and hence statistically this method is poor. A weighting system can be used to try to attribute importance to the points that are believed

*duration here refers to the era over which records had been kept.

to be most nearly correct and hence reduce the inequality of the errors. As soon as a weighting system is adopted some form of subjective bias is implied. The interdependence of the plotted points cannot be overcome. None the less this method is widely used and a and b are calculated from the curve fitted.

3.2.2 Maximum Likelihood

Study of earthquake events has shown that they appear to follow a Poisson process and this is the basis of the maximum likelihood approach. The Poisson process is adopted as the model and by the theory of maximum likelihood parameters of the distribution are assessed and the equivalent of values a and b calculated.

3.2.3 Extreme Value

There are several extreme value techniques used but generally two of Gumbel's distribution are preferred, Type I and Type III.

In both techniques all data is examined and then only annual extremes abstracted and the other data is not used at all. This means that only maximum events for each year need be recorded and in the case where very limited data is available only large events may be known. However for a typical example in South Australia this means for a record from say 1963-1979 when data has been recorded that there are only 17 usable data points of an available thousand or so. It is possible to use any period of time with Gumbels extreme value theory but generally in the literature only annual extremes are used.

The data is plotted on a double natural logarithmic plot when using Type I or Type III methods and a curve fitting process used. The Type I curve is straight on this plot and the Type III is curved and from this a maximum magnitude can be established as a bonus. The equivalent of the values a and b can be assessed from a Type I analysis. The Type III analysis is similar in result to the theory expressed by Makjanic (1980) discussed earlier.

3.2.4 Seismic Moment

Recurrence relationships can be derived by use of the seismic moment method which has the advantage that it uses an energy consideration to derive the recurrence.

The equation (Stewart (1981))

$$\log M_o \text{ (dyne. cm)} = c + d\, M_L \qquad (3.2)$$

is used to find the seismic moment M_o given values of M_L, Richter magnitude, and the constants c and d. Seismic moment is then summed and moment rate calculated. The above mentioned advantage of the method is that low magnitude events have little effect on the summed seismic moment (see equation 3. 2) Hence undetected small events have little error contribution to the final summed moment, negating to some extent the unreliability of historical records of smaller events. This greater reliance on the larger events and consequent mathematical disregard for the smaller events embodies in some way the principles and criticisms of the extreme value method: a strong reliance on a few well recorded larger events for which magnitudes are accepted to be accurate to within only half a unit, McCue (1975). Another disadvantage of the method lies in the constants c and d which are further unknowns which have to be estimated from data obtained overseas. The introduction of a need for values of c and d represents yet another unknown in the seismic risk process which the other recurrence methods do not require. The principle of the theory of seismic moment is that larger events cause considerable crustal stress relief which leads to apparent quiescence in the vicinity of those larger events for some time. The principle points to one of the dangers of seismic risk assessment: that apparently quiescent areas are probably the most difficult to zone and need the most cautious approach. An area can be quiescent because it is seismically inactive or because it is about to produce a major event!

Seismic moment is not considered further as c and d are additional variables, but the principle of the method should be noted in a cautionary way when considering seismically quiet regions. Stewart (1981) used South Australia to demonstrate the method of seismic moment and compared it with a Cornell analysis. The methods he used to spread the seismic moment could equally be applied to a Cornell style analysis in the same area:

"unit zones 0.2 degrees square containing at least one event (in a source area) are assumed to be equally active in the long term."

The results of Cornell and seismic moment would probably then concur. The differences Stewart obtained in zoning for South Australia from the work of McCue (1975) stem mainly from the modified data base Stewart used. He converted local magnitudes of data after 1969 using the conversion Stewart (1975), not Stewart (1972) as McCue had done. This has a substantial effect on the derived recurrence relationship, Stewart (1972) giving larger magnitudes for larger events than Stewart (1975). Several larger events occurred between 1969 and 1974, part of the era of the data McCue used.

3.2.5 Discussion of recurrence methods

Milne and Davenport (1969) used average numbers and extreme value techniques to assess seismic hazard in Canada. They preferred the extreme value method for solution. Knopoff and Kagen (1977) showed that the extreme value method gave unacceptably large probable errors and preferred methods using all available data. Weichert and Milne (1979) re-examined the argument as to which method to use and showed that the extreme value method as used by Milne and Davenport previously shows no advantages over the average numbers method. However, when data is known to be incomplete, uses for extreme value methods did arise. Weichert and Milne showed that with realistic random data standard deviations for extreme value analysis were considerably larger than with average numbers methods. They then went on to suggest a modification to the average numbers technique by using an incremental frequency magnitude plot (instead of cumulative frequency) and the examination of any evidence of data incompleteness. Basham, Weichert and Berry (1979) used the modified technique to assess the seismic hazard in Eastern Canada and noted that a comparison with extreme value techniques showed that the latter gave unstable solutions. Lommitz (1980) commented that he thought that Weichert and Milne (1979) were perhaps not entirely correct in deviating from the extreme value method as larger earthquake events are better recorded than smaller events and much less likely to be overlooked in a catalogue. Perhaps there is some minor misunderstanding here as Weichert and Milne (1979) did allow that, for incomplete data sets, extreme value methods did have their place. They would appear to concur with Lomnitz's view subject to that proviso. The writer agrees with this general principal which appears to evolve: when the data is complete and well recorded or as nearly as is reasonably possible an analysis using all the data is better than one using an extreme value distribution which automatically disregards large quantities of data. The writer has also found that the statistically crude method of average numbers with a weighting bias to alleviate the effect of one of its errors, non independence of the data points, gives a very stable solution if one varies the lower limit magnitude range which is considered (Figure 3.5).

A comparison with the statistically preferred Poissonean modelled maximum likelihood method shows that as the magnitude range is varied the solution appears unstable. This instability is attributed to the sensitivity of the model to any gaps in the data which may occur for reasons of lack of sensitivity of detection in remote areas of the basin* considered or consistent miscalculations of magnitude. If the two methods, weighted average numbers and maximum likelihood, are used in conjunction, it is possible to assess where the solutions converge and are parallel to the magnitude range abscissa. When this occurs one is probably then approaching the best data range from that set. The solution for a Gumbel Extreme Value Type 1 method of solution is also shown. (This is insensitive to magnitude range lower limit variation as it considers only maximum events). It has also been noted that the extreme value technique can be applied to other than annual maxima and a variety of solutions can be obtained by (a) varying the commencement date of an

*basin is used here as a region within which seismic activity consistently occurs.

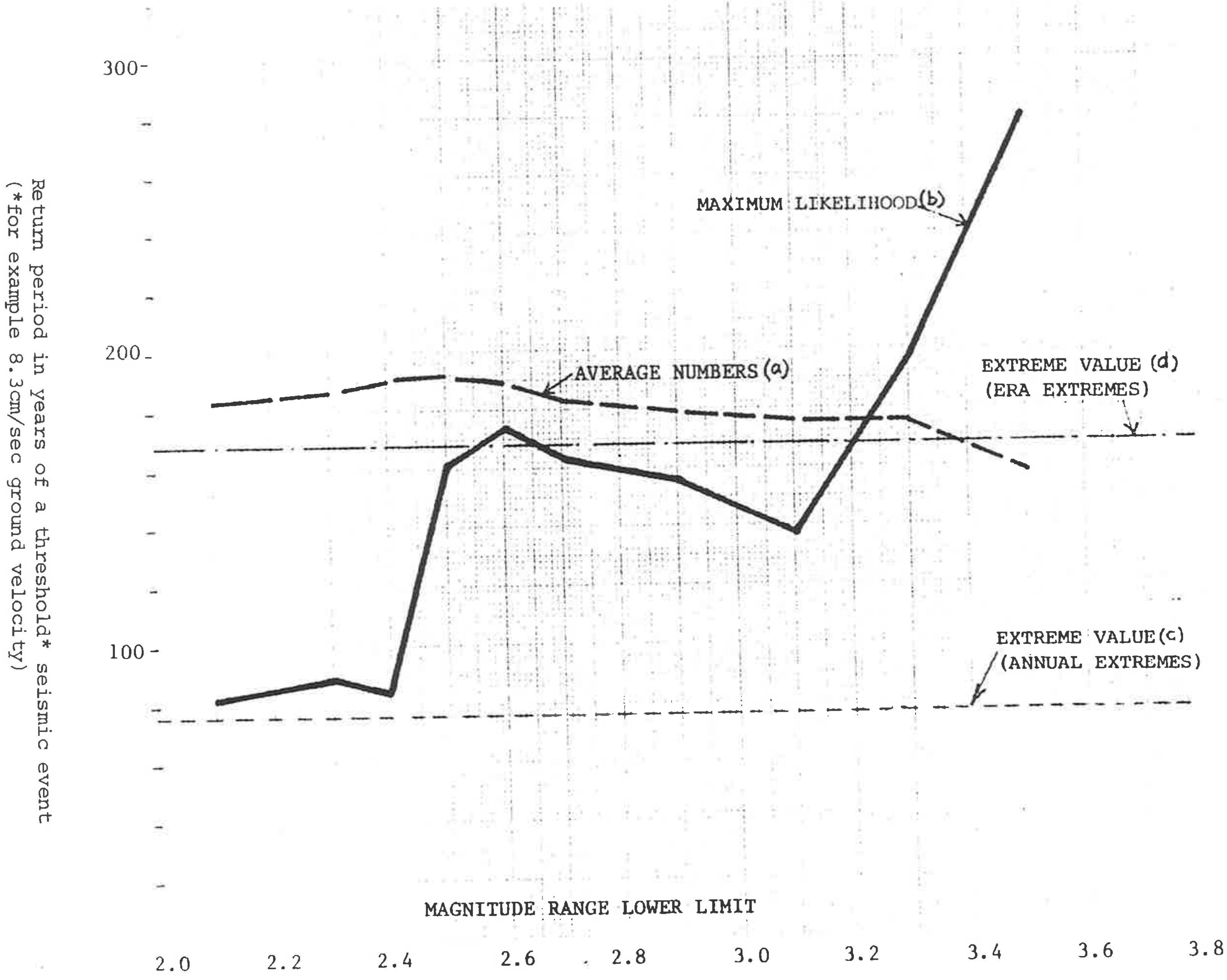

300
200
100
Return period in years of a threshold* seismic event
(*for example 8.3cm/sec ground velocity)
MAXIMUM LIKELIHOOD (b)
AVERAGE NUMBERS (a)
EXTREME VALUE (d)
(ERA EXTREMES)
EXTREME VALUE (c)
(ANNUAL EXTREMES)
MAGNITUDE RANGE LOWER LIMIT
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8

FIGURE 3.5

annual period considered or (b) using shorter/longer periods of data than one year. In addition for example if the fourteen maxima are taken in the fourteen years of record instead of the fourteen annual maxima a solution that is very close to the average numbers solution emerges. This may not be within the original intentions of Gumbels original analysis technique. (see fig. 3.5 curve d).

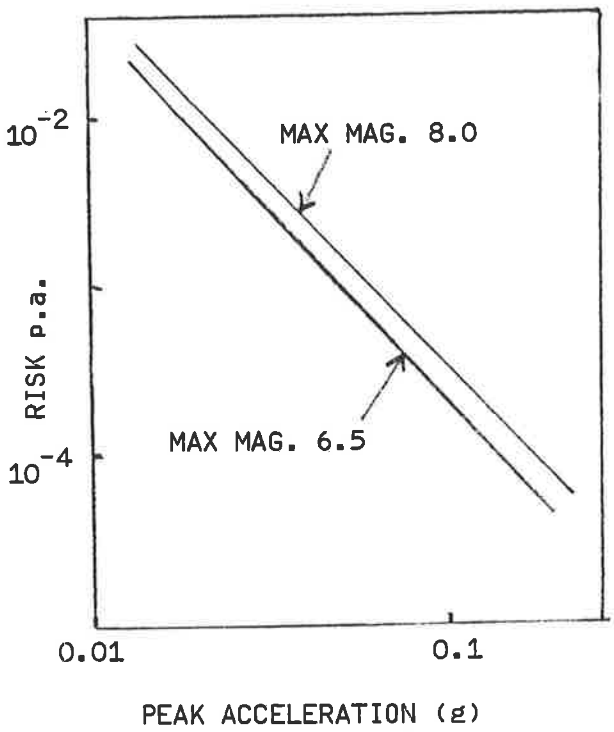
3.2.6 Maximum Possible Magnitude

Though statistically an ill-defined term, maximum possible magnitudes are often used to curtail recurrence relationships. Maximum possible magnitude can be determined in a variety of ways. As previously noted the Gumbel Type III extreme value analysis which exhibits curvature on a double logarithimic plot of probability versus magnitude reveals a maximum possible magnitude limit (see Fig. 3.2).

Yegulalp and Kuo (1974) examined earthquake records for most regions of the world using Gumbel Type III analysis and as previously stated noted little curvature for Australian data consistent with the characteristics of other stable continental masses. They state that for 20, 50 & 100 year periods the maximum magnitudes would be 6.3, 6.7 and 7.0 respectively; no maximum possible magnitudes are assigned.

Burton (1979) used Gumbel Type III analysis and noted that in a region from Southern Europe to India using data from 1900-1974 an upper bound to the magnitude of occurrence is discernible but its value is often uncertain.

Basham, Weichert and Berry (1979) state, logically, that the "maximum magnitude earthquake" should be judged to be larger than any historical earthquake in the zone. They go on to assign maximum magnitudes as approximately one unit larger than the largest historical event. They then show in their Figure 13 (see Figure 3.6) that there is little effect if the maximum magnitude were varied from M = 6.5 to 8.0 (a credible range for the example given) on the calculated risk except for very long return period events in excess of 1000 years. Figure C3 shows this effect in South Australia for a site in the Northern Spencer Gulf. The maximum possible magnitudes of 6.5, 7.6 and infinity were used for a finite basin area. The risk variations are small for shorter return periods. If a finite basin region is used with a Cornell (1968) style analysis the maximum magnitude has little effect on risk analysis and it is possible to do analyses with no magnitude limit if basin bounds are defined so that no excessively large events are needed to give threshold effects at the site for which hazard is being defined.



FROM BASHAM WEICHERT AND BERRY (1979)

FIGURE 3.6

3.3 Attenuation relationship

In sections 3.1 (Spatial distributions) and 3.2 (recurrence relationships) the characteristics of the source of the seismic events have been established. It remains for us to establish the effects from the source and see how they vary with magnitude and distance from the source. The effects are the ground motions produced by the event and the variations are the attenuation relationship.

The way in which seismic waves, propagating from an event source, produce ground motions is an extremely complex one. There are analytical methods being used by researchers but these are mainly to assess the local effects that can occur with layered soil deposits and have not been used to predict effects over the longer distances normally considered by attenuation equations. Most attenuation equations have been derived empirically from recorded effects by application of statistical analyses to give regional equations, (Esteva and Villaverde, 1973).

It has therefore been established that certain effects or characteristics of the ground motion need to be measured in order to derive an attenuation relationship for a region. Strong motion instruments generally record the time history of accelerations in three orthogonal directions; two perpendicular horizontal traces and one vertical trace. From the time history of acceleration it is possible by integration to then calculate velocity and hence displacement histories as well. Several corrections have to be applied to the traces to allow for instrument period, base line correction, initial velocity and displacement. Peak horizontal acceleration and velocity are generally the parameters most widely used in attenuation relationships. However peak horizontal displacement, peak vertical acceleration, peak vertical velocity, peak vertical displacement, spectral content and duration are also used to describe ground motions. Peak acceleration and velocity are the most useful ground motion descriptions to the design engineer and are generally only required for horizontal effects. If vertical effects are required, scaling of the horizontal effects is usually regarded as sufficient.* Peak velocity is probably the parameter of greatest single interest to the structural design engineer. When a response spectrum is drawn up, it is normal to find that the dominant period of structures falls on the peak velocity limit of the spectrum and the peak acceleration limit is rarely used. The Australian Code AS 2121-1979 sensibly uses velocity for zoning but for ease of calculation effectively converts that to an equivalent acceleration for quasi static analysis. Idriss (1978) attempted to collate the available equations and detailed thirteen references of ground motion parameters mainly defining acceleration and velocity. Some of those attenuation relationships are very specific; for example, that of Duke, Eguchi, Campbell and Chow (1976) is for Richter magnitude 6.4 only, being established from the 1971 San Fernando earthquake records. Others are more general (Esteva and Villaverde (1973) (firm ground) and McGuire (1978)

*this simple assumption is made due to the lack of better data.

(rock or stiff soil sites)). Idriss (1978) lists in excess of 80 available ground motion parameter equations, all based on an empirical approach. More attenuation equations have been derived since e.g. Hasegawa, Basham, Berry (1981) and others modified with further experience. Observers have also taken sets of attenuation equations which purport to define the ground motion parameters and use techniques to produce mean relationships (Makropoulos, 1978). This leaves the seismic risk analyst with a vast array of equations from which rational selection becomes difficult. If data is available in sufficient quantity and of sufficient quality it is possible to plot the data and hence select the most suitable relationship. However, with sufficient data to assess which relationship is best it may be better to derive a local attenuation relationship.

Section 4.4 examines this matter in more detail.

CHAPTER 4

4.1 South Australian Seismicity

As a continent Australia is not a seismically active area by world standards. Yegulalp and Kuo (1974) describe it as a stable continental mass. However, within Australia attempts have been made to assess regions of seismic activity by McCue (1973, 1975, 1977) and by McEwin, Underwood and Denham (1975). These seismic risk assessments were examined by the expert opinion of a Seismic Zoning Sub Committee for the production of a Seismic Zoning Map of Australia to be read in conjunction with a modified UBC Seismic Loading Code (AS 2121-1979). The Seismic Zoning Sub Committee was presented with a difficult task as all the seismic risk assessments were based on very short term data and hence could be indicative only. Through the above mentioned analyses together with consideration of the physical and geological conditions prevailing in Australia, the continent was subdivided into roundly ten active areas where seismic activity appeared to merit consideration at that time. Four regions were identified in Western Australia, one on the South Australia/ Northern Territory border, one in South Australia, one in Victoria, one in New South Wales, one in Queensland and one in Bass Strait around the Furneaux Island Group. Eight of the regions identified were considered active enough to require seismic consideration for all major structures, (Zone 1), and three of the regions contained, in addition, areas of higher activity (Zone 2). Of the state capital cities, Adelaide was designated as Zone 1, Perth was designated as Zone A, (relatively low risk), and part of Sydney was also designated as Zone A. Melbourne miraculously escaped zoning but is virtually surrounded by Zone A areas. Adelaide had thereby become the "earthquake capital" of Australia. In addition, South Australia had acquired part of two of the only three Zone 2 areas in Australia. From this assessment South Australia would appear to be the principle earthquake state, though there is little doubt that Western Australia Cadoux/Meckering area is the most active area historically. Therefore though by world standards Australian seismicity is low, by Australian standards South Australian seismicity is relatively high.

4.2 Spatial Distribution of Events in South Australia

Figure 4.1 shows some of the events recorded in South Australia and Figure 4.2 shows the known tectonic basins in the same area. It is evident from the comparison of these two figures that there are currently active and inactive basins in South Australia. A debate exists as to whether the inactive areas are dormant seismic areas or not. The principle of the theory of the seismic moment method (see section 3.2.4) is that there will be large blank areas of seismic activity as part of the slip and strain accumulations along defined active seismic faulting lines. Stewart (1981) refers to lengths of up to 120 km which could be expected to be, in effect, stress relieved by the occurrence of large events nearby and hence would appear dormant. The chances of these apparently dormant areas producing earthquakes at

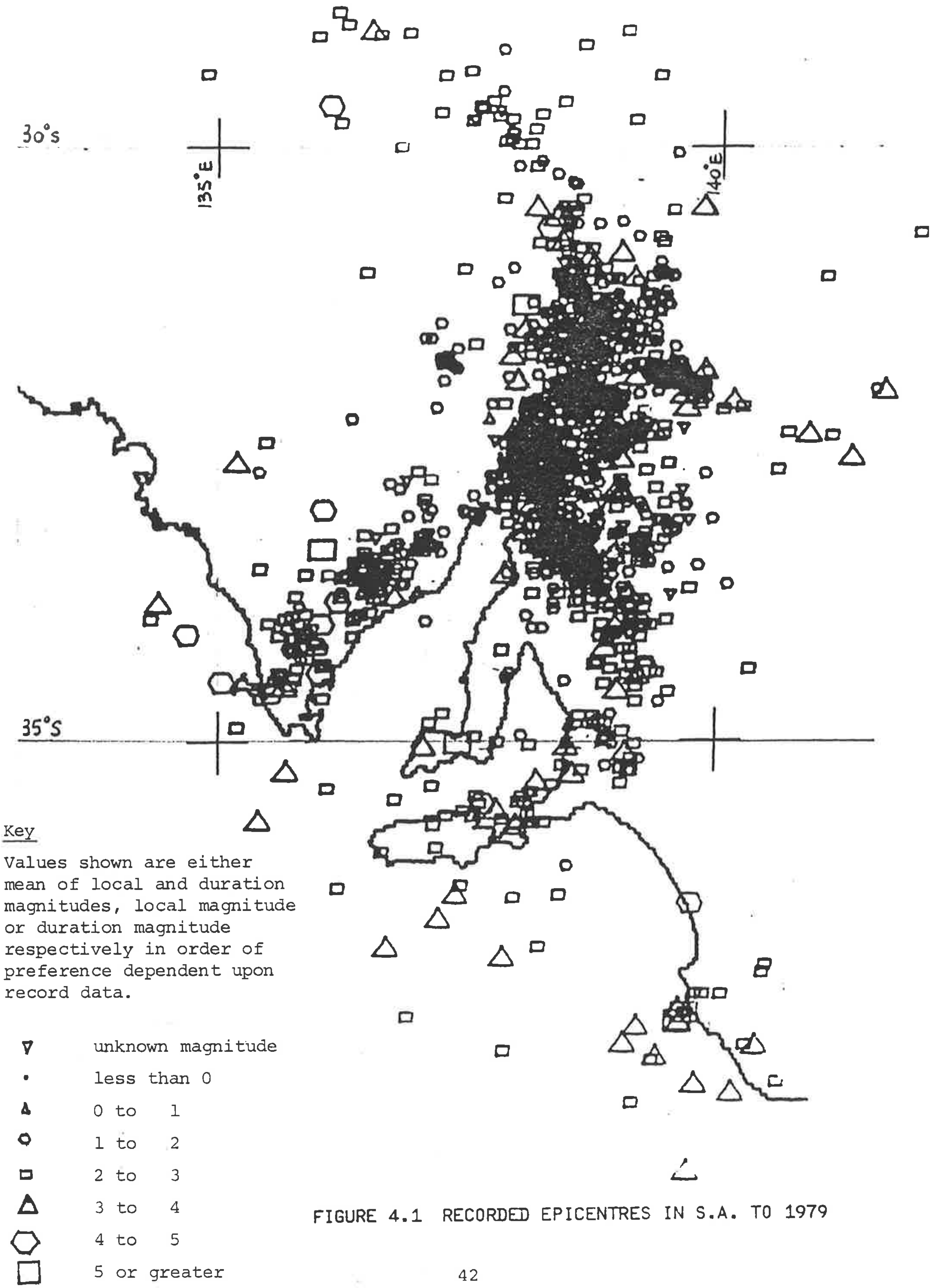


FIGURE 4.1 RECORDED EPICENTRES IN S.A. TO 1979

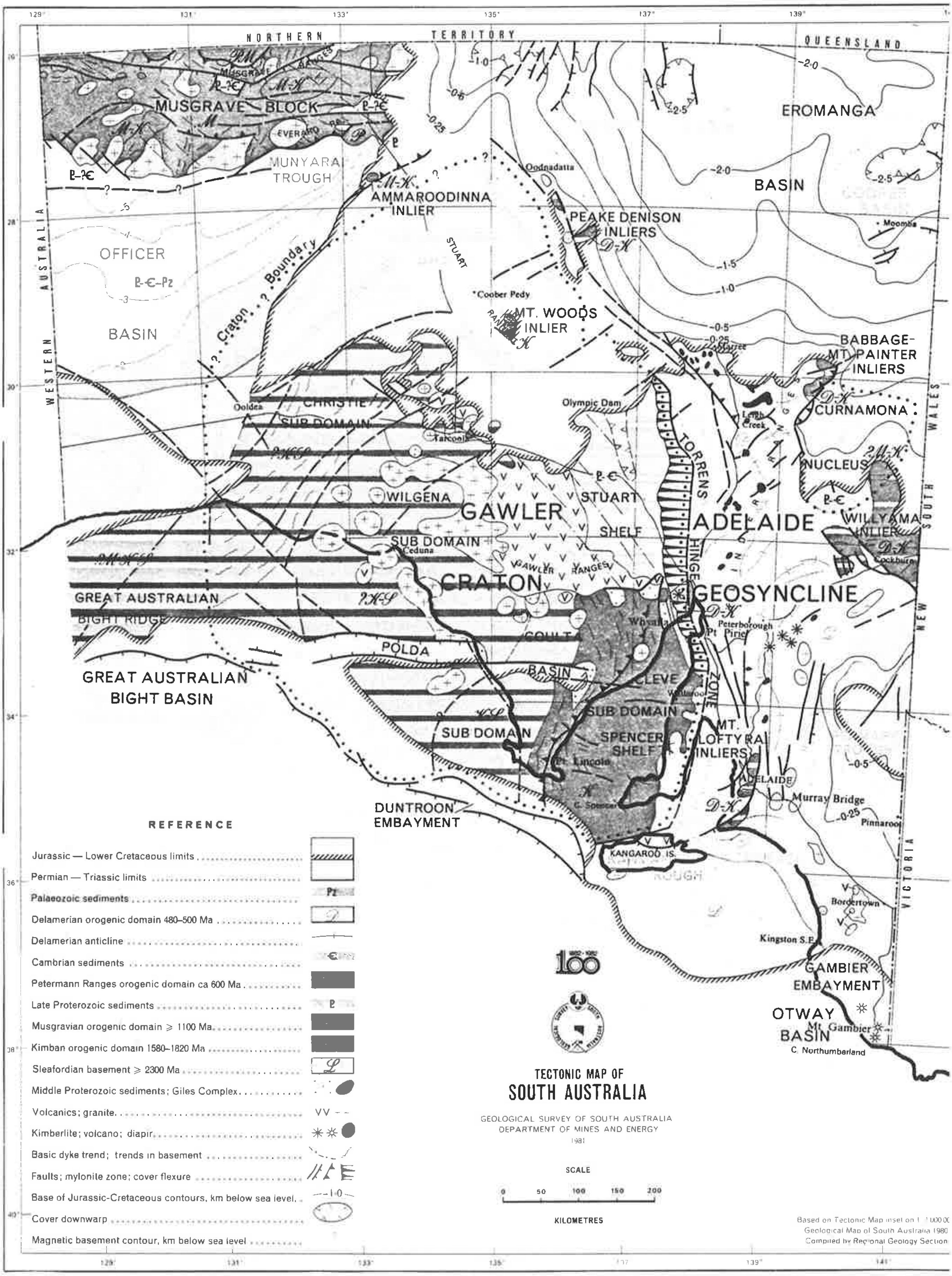


FIGURE 4.2 TECTONIC MAP OF SOUTH AUSTRALIA

later dates are regarded as similar therefore to the chances of an event occurring in an already active area. In terms of background seismic activity this means that events can occur anywhere where faults can be identified as potentially active. The effect of considering that apparently dormant areas are likely to be active is to increase the background activity level and reduce the peak activity in active areas. If consideration is given to only the areas that appear active at present in South Australia several source regions can be identified. The Adelaide Geosyncline, Eyre Peninsula and the Otway basin appear to be the most active of these regions. McCue (1975) gives a detailed description of the geological and tectonic background to S.A. seismicity. The Adelaide Geosyncline is a large region about 600 kms by 300 kms and has historically been examined as a single source region mainly because of lack of accumulated data. It is becoming apparent that this region is more active in the north than the south and hence on that basis alone the apparent geological division, the Adelaide Geosyncline, could be further subdivided for seismic analysis purposes. Figure 4.3 shows significant epicentres (5.0 Richter magnitude or greater) recorded since 1836. Again it appears that more epicentres occur in the north of the geosyncline than in the south. However, it would appear that in proportion to the total recorded events (Figure 4.1) more larger events have occurred in the south than in the north. Further subdivisions of the Adelaide Geosyncline can be made; north of 33°S there is identified diapiric seismic activity and this mechanism is probably different from that causing seismic activity in the southern

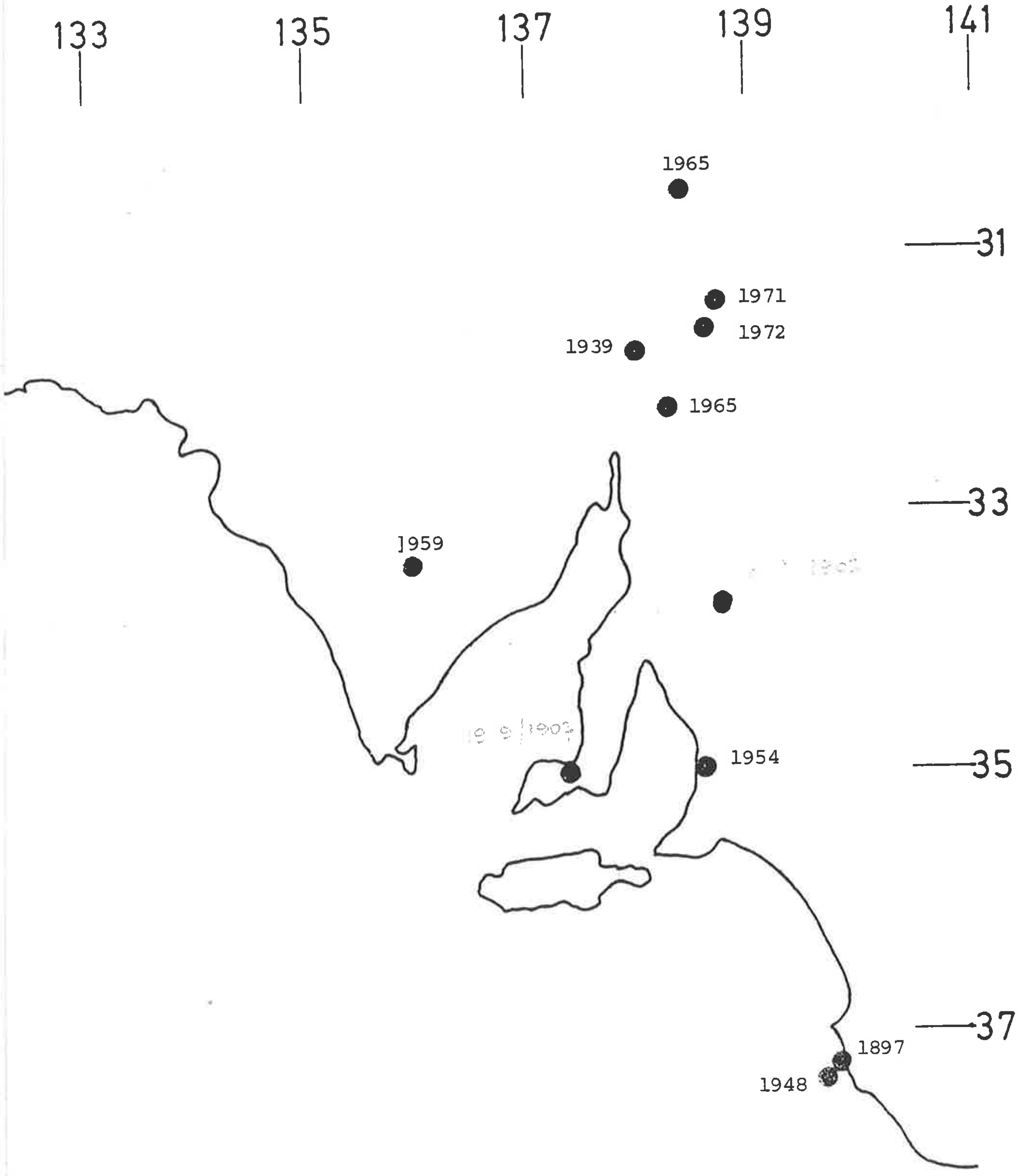


Figure 4.3 Recorded Epicentres of Richter Magnitude 5.0 or greater 1836-1979

region. Uniformity of activity is difficult to assess as data records are short, but it appears that some of the activity of the Adelaide Geosyncline can be attributed to known geological faults, e.g. the eastern side of Spencer Gulf. The distribution of activity at any cross section of the basin in this region appears to indicate greater activity rates at the edges of the basin (the faults) than is general within the basin itself. There appears to be insufficient data available at present to identify whether this high activity rate at the boundary of the basin is associated with differing magnitude ranges from the intra basin activity or not. Examination of the data shows no clear trends yet. To incorporate the apparently higher inter basin activity rate into a risk analysis the writer has introduced two forms of analysis the conventional "uniform" activity analysis and a "local activity" analysis. When a "uniform" analysis activity is performed it is assumed that the calculated activity, in the basin area postulated, is distributed uniformly within that area, whether events have occurred throughout the basin area postulated or not. When a "local" activity analysis is performed, the assumption is made that the events used reflect a distribution which will occur in the future. In other words the probability of a given magnitude event occurring in a pixel* is distributed on a basis directly proportionate to the number of events that have occurred in that pixel historically

*pixel is defined in section 5.1.

relative to the basin total. Another more complicated way of achieving this non-uniform distribution equivalent to the "local" analysis would be to assume a line source of events along the basin edge fault and a separate slightly smaller basin adjacent to it. The boundary between the line and area source would be a matter for detailed assessment and subjective decision. This area/line method would be necessary if it could be clearly shown that the recurrence relationship for events on the line source and in the area source were different or exhibit different Gutenberg Richter b values.

To take best advantage of the uniform/local analysis facility in seismic risk analysis it is suggested that both be performed and the variation can then be assessed between the solutions to give the analyst some measure of the assumptions made in the analysis.

In addition to enabling the changes in activity within a basin to be more rationally dealt with, the local activity analysis also enables analysis to be done where no basin is clearly defined. For example, when the seismic activity around Adelaide is examined it would appear that there have been several events along the projection of the Burnside Eden fault suggesting a line source. However by no means do all events lie on this fault and again there appears to be little conclusive evidence that the magnitudes of events along this fault are distributed any differently from those elsewhere in the region. Only continuing data collection can hope to change that situation. Meanwhile, it is possible by setting some limits to basin size, by using a local activity analysis, to take into account the distribution of events along the fault and the other background events. The source size because of the local activity analysis becomes less critical because of its automatic adjustment of probabilities to the local epicentre distribution; as the basin size is increased the probability of a given event occurring increases, but the local activity factor decreases that effect, giving a fairly stable solution regardless of basin size, within the limits of commonsense.

4.3 Recurrence Relationships in South Australia

Figure 3.4 shows the accumulated data for 1966 to 1979 within the region from 28° South to 38° South and from 135° East to 141° East an area which represents substantially the seismic activity in South Australia. Two curves are fitted to the data one by the average numbers technique with square root weighting (ANSRW) of points and the other by the maximum likelihood method (MLM). Over such a large area, observation is by no means complete, particularly for small magnitude events at distant locations. Extrapolation of these curves is needed to obtain the final seismic risk analysis and at magnitude 5.0 ANSRW method gives 7.4 years return period and MLM method 4.4 years. At the upper limit of say magnitude 7.6 the return periods are 1722 and 484 years respectively. Both curves are fitted using magnitude 2.5 as the lowest detectable magnitude. This substantial variation in return periods from the recurrence relationships derived leads ultimately to, only about half a zone variation (zone from AS 2121-1979) in final risk assessed for a given site. Using historical data that is available for that area and assuming that all events are recorded above say magnitude 5.0 (possibly remote events of this magnitude may not have been noted in the early days of South Australia's colonisation) and noting that South Australia has been settled since 1836 (i.e. 143 years), it is possible to plot on an extrapolated curve of figure 3.4 using more data and see how well it appears to fit. This is shown on figure 4.4. The data appears to favour the lower curve, ANSRW.

Other recurrence relationships can be derived for each source area discussed in section 4.2. For each one derived, a check can be made by comparing various methods (see section 3.2.5) and magnitude ranges and cross correlating the resultant curve with historic data where possible.

4.4 Attenuation Relationships in South Australia

As discussed previously (Section 3.3) numerous attenuation relationships are available for a variety of ground motion parameters. Peak velocity is the relationship of most interest, though if peak acceleration is used as well, a meaningful response spectrum can be drawn up from which most structures can be analysed.

In South Australia little data is available and there is certainly

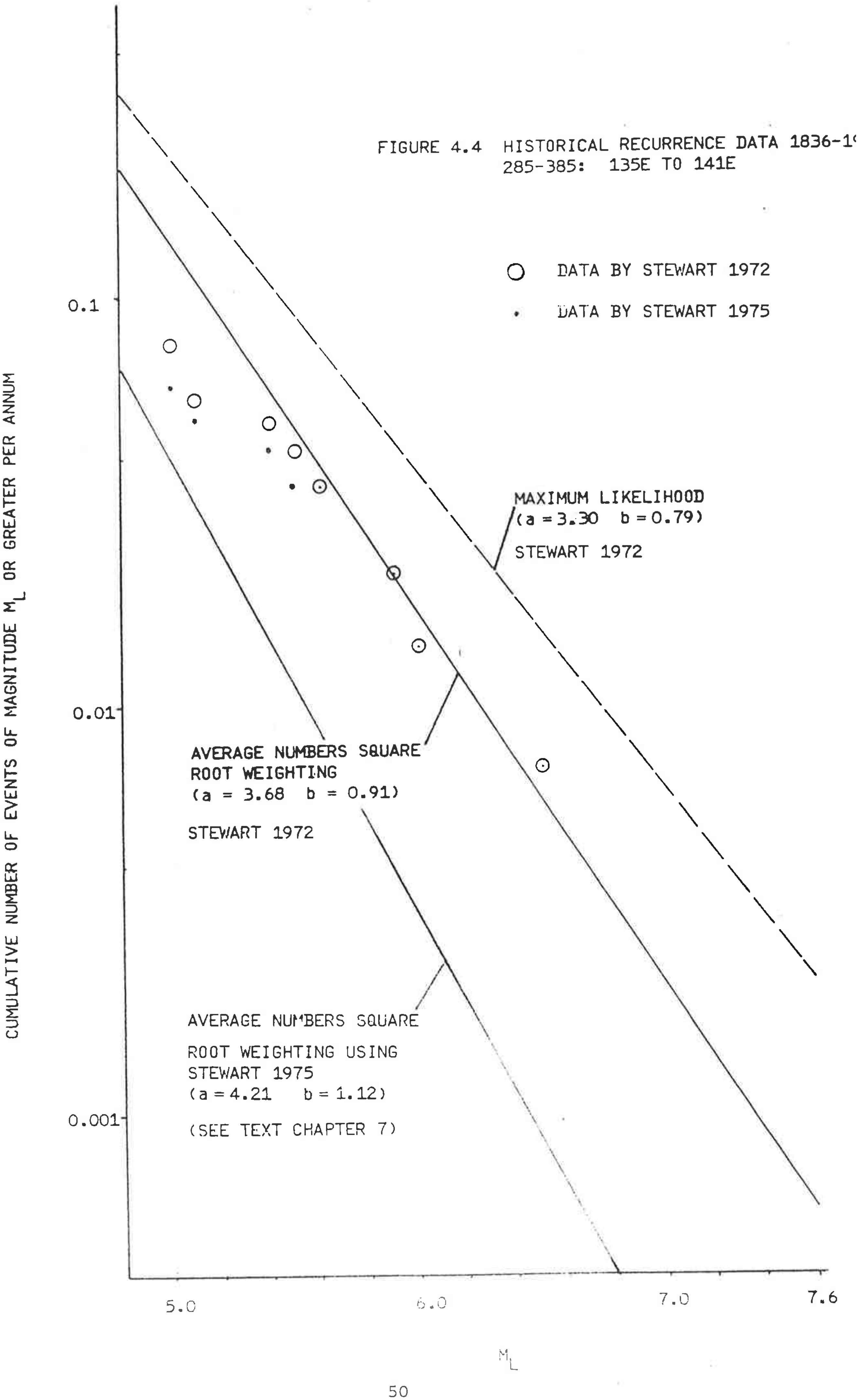


FIGURE 4.4 HISTORICAL RECURRENCE DATA 1836-19
285-385: 135E TO 141E
DATA BY STEWART 1972
DATA BY STEWART 1975
MAXIMUM LIKELIHOOD
(a = 3.30 b = 0.79)
STEWART 1972
AVERAGE NUMBERS SQUARE ROOT WEIGHTING
(a = 3.68 b = 0.91)
STEWART 1972
AVERAGE NUMBERS SQUARE ROOT WEIGHTING USING STEWART 1975
(a = 4.21 b = 1.12)
(SEE TEXT CHAPTER 7)
CUMULATIVE NUMBER OF EVENTS OF MAGNITUDE M_L OR GREATER PER ANNUM
0.1
0.01
0.001
5.0
6.0
7.0
7.6
M_L

an inadequate amount of data to derive a local attenuation relationship. It would appear, unfortunately, that, due to the close relative proximities of strong motion recording instruments installed to date in South Australia in the event of an earthquake, little data will be obtained on attenuation rates. Other useful data may however be recorded. The currently available data for checking attenuation equations is in the form of Modified Mercalli Intensity (I) diagrams which can be crudely converted to ground velocities (v). Presumably this will be the form of future data too, if funding can be found at the time of an event to justify collecting the vast amount of subjective information necessary to produce such diagrams. McEwin Underwood and Denham (1976) suggest that it would be unlikely that an attenuation relationship would be uniform throughout Australia. This observation is logical in view of the variety of geological formations in Australia and the variety of seismic activity rates. In the United States, (Chandra, 1979), and in Canada, (Hasegawa, Basham and Berry, 1981), there are clearly observed variations in rates of attenuation of ground motions with distance in different regions. Hence it is not possible, in this instance, to rely on other sources of data in order to check which attenuation equations best fit the local attenuation records. Local records must be made.

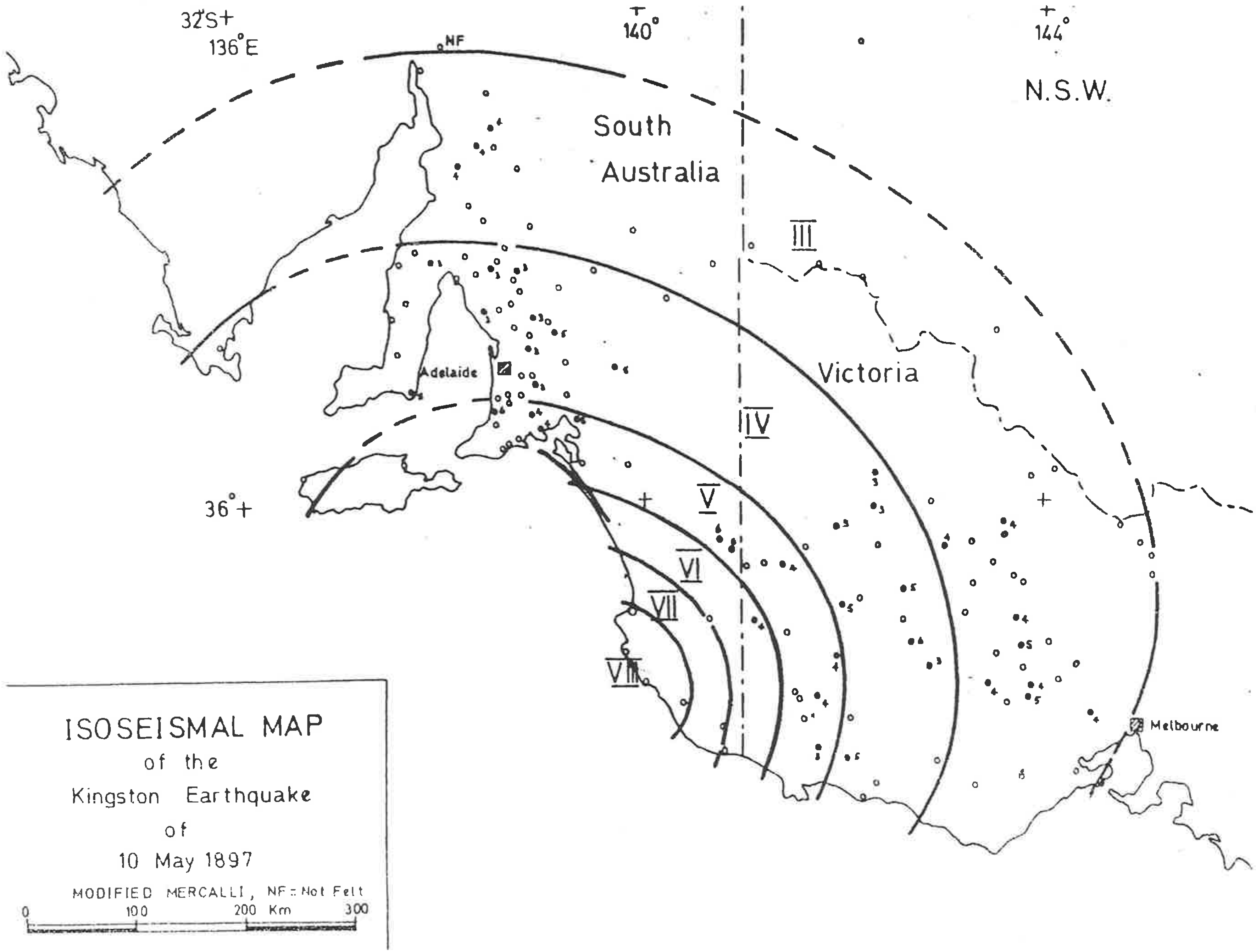
The records that are at present available are very scant and subjective and are in the form of Modified Mercalli Intensity diagrams for seven historically observed events. McCue (1975) used the then available data to justify his selection of the Esteva (1973) attenuation equation set (velocity and acceleration). Since that time other seismic risk analyses have been done in South Australia. McEwin, Underwood and Denham (1976), Chaplow (1977) and Stewart (1981) have all favoured Esteva's equations though McEwin, Underwood and Denham used his (Esteva's) earlier 1964 relationship. Work done in the United States by Chandra (1979) and in Canada by Hasegawa, Basham and Berry (1981) suggests it is likely that the kind of attenuation relationship that an intra-tectonic plate structure (such as South Australia is believed to be) exhibits would be different from that of an inter-plate structure. Attenuation rates appear to be greater at larger distances for inter-plate activity than for intra plate activity. Hasegawa, Basham and Berry (1981) show that, in the case of large epicentral distances, attenuation rates may vary such that factors of up to three exist in values of ground motion parameters. In effect this increases the "felt" area of an earthquake event. As the available data is quite scant it seemed to be of little value to attempt to examine numerous attenuation equations and their fit to the data. However, some attempts have been made to match data with four velocity attenuation equations of particular interest. Esteva's much quoted 1973 equations were selected (his earlier 1964 equation favoured by McEwin, Underwood and Denham (1976) was not examined). Hasegawa, Basham and Berry's 1981 equations were also selected as (a) they represented new equations recently derived and (b) they came in two forms for Western Canada and eastern Canada presumably illustrating interplate and intra-plate attenuation variations. Finally the velocity attenuation equation of McGuire (1978) was used for a soil site.

McGuire's equations have been used for risk analyses and have been used "locally" in New Zealand by Peek (1980). In South Australia events up to 7.6 Richter magnitude the estimated maximum event (McCue 1975) are of interest and down to about 5.0, the estimated threshold for structural damage for an event typically at about 15 km depth. The isoseismal maps that are available are for events of Richter magnitude 4.25 to 6.5 (see Figures 4.5 to 4.13). These events are widely scattered throughout South Australia at Kingston (6.5), Warooka (6.0) (two diagrams), Robe (5.6), Adelaide (5.25), Quorn (5.0), Spalding (4.6) and Mt. Barker (4.25) an overall distance of 550 km or so apart. The events are also widely scattered in time, from 1883 to 1971, and records of earlier events may be poorly recorded. In addition population in most of these areas was sparsely distributed (particularly in 1800's) and structures by which to estimate effects were few. Combining these facts with the inevitable subjectivity of the assessment in producing a Modified Mercalli Intensity diagram (the scale is reproduced in Appendix A) and then a conversion to a velocity parameter, v, using Newmark and Rosenblueths (1971) equation

$$I = \frac{\log 14v}{\log 2} \; *$$

leads one to some very tenuous data points. It should also be noted that the magnitude values ascribed to these events are also estimates.

* For more detail see Rosenblueth E. Probabilistic Design to Resist Earthquakes Proc ASCE 90 EM5 PP 189-215.


32°S
136°E
140°
144°
NF
South Australia
N.S.W.
Victoria
Adelaide
Melbourne
III
IV
V
VI
VII
VIII
36°
ISOSEISMAL MAP
of the
Kingston Earthquake
of
10 May 1897
MODIFIED MERCALLI, NF = Not Felt
0
100
200 Km
300

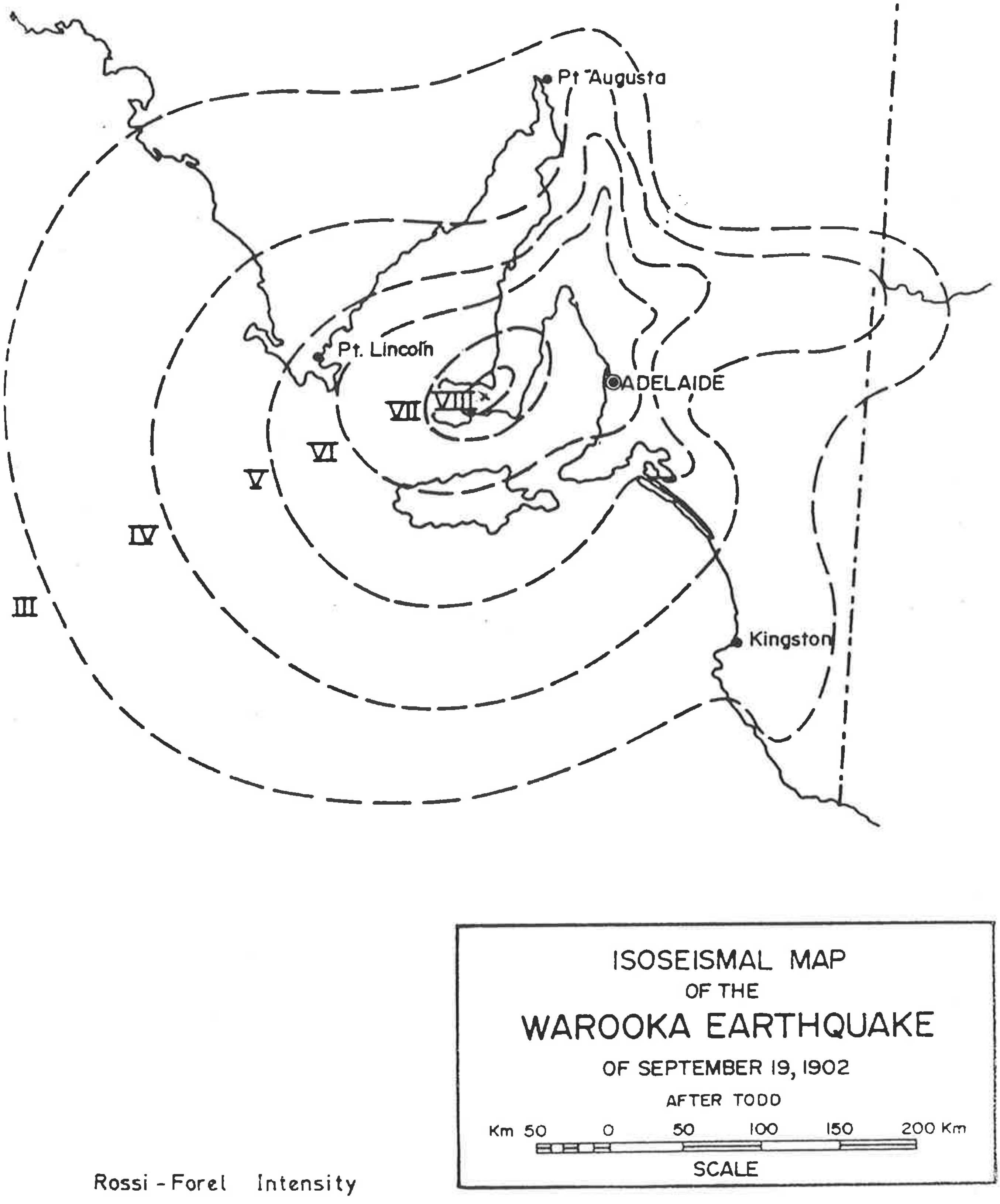


FIGURE 4.6 $M_L = 6.0$

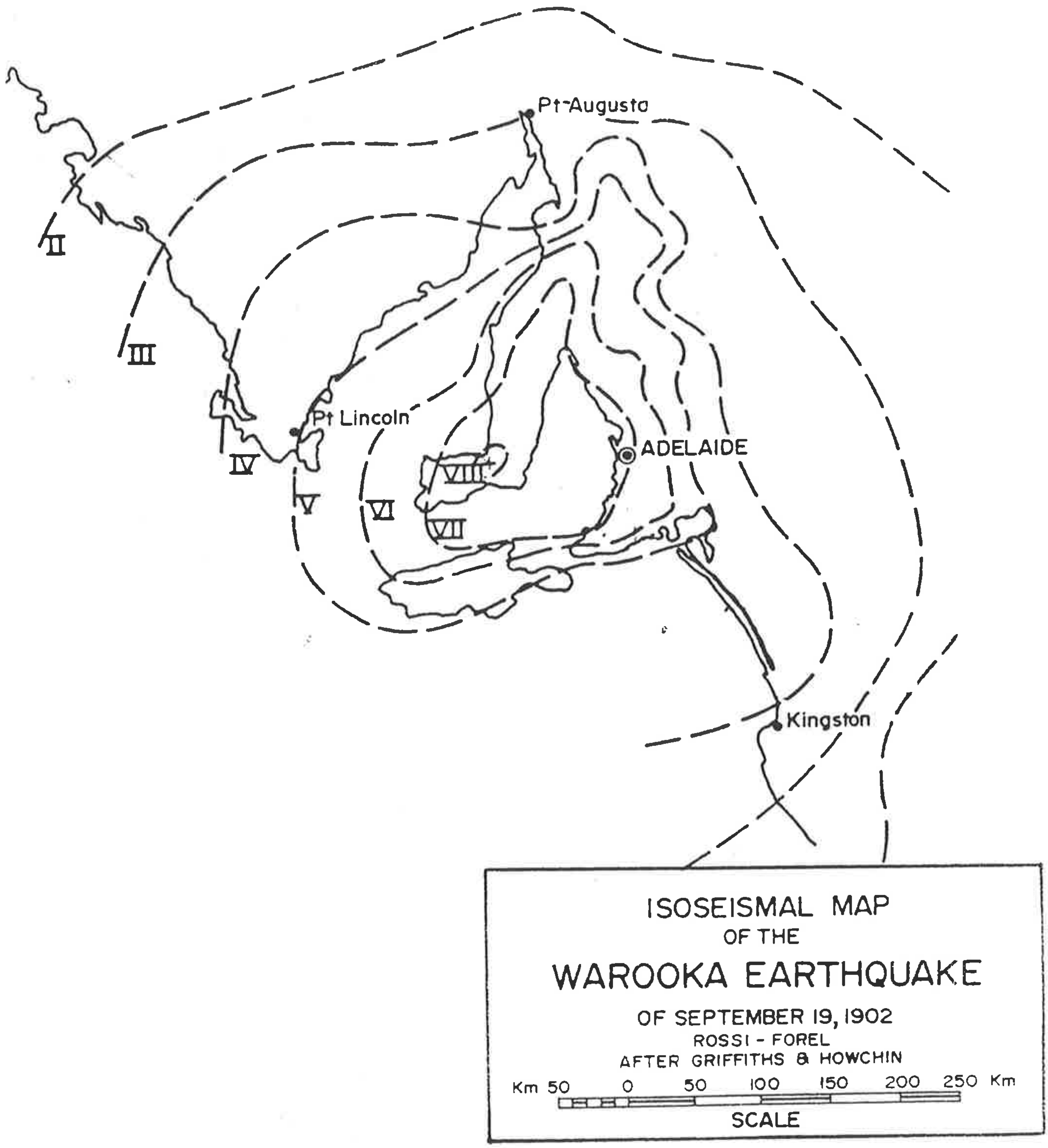


FIGURE 4.7 M_L = 6.0

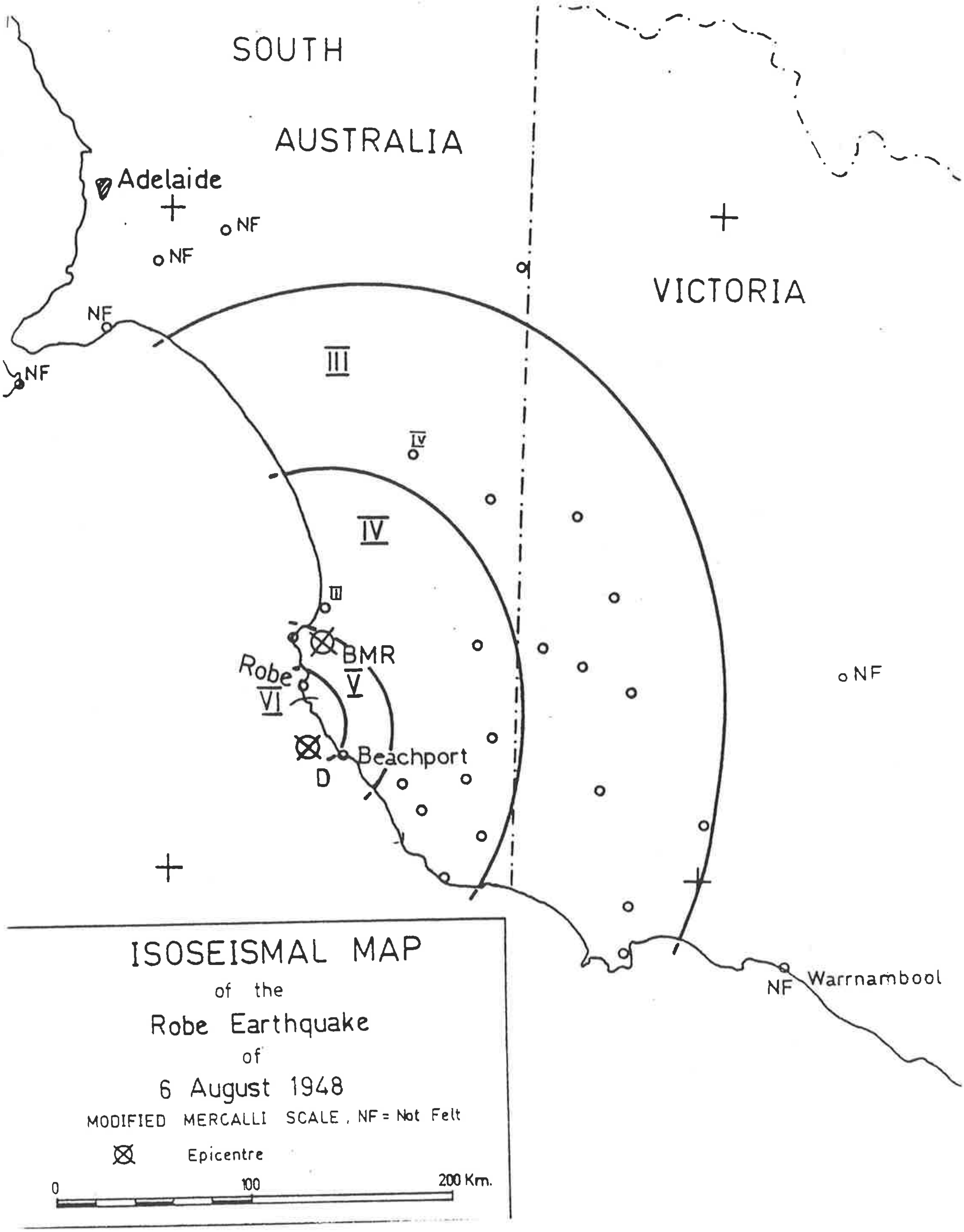


FIGURE 4.8 M_L = 5.6

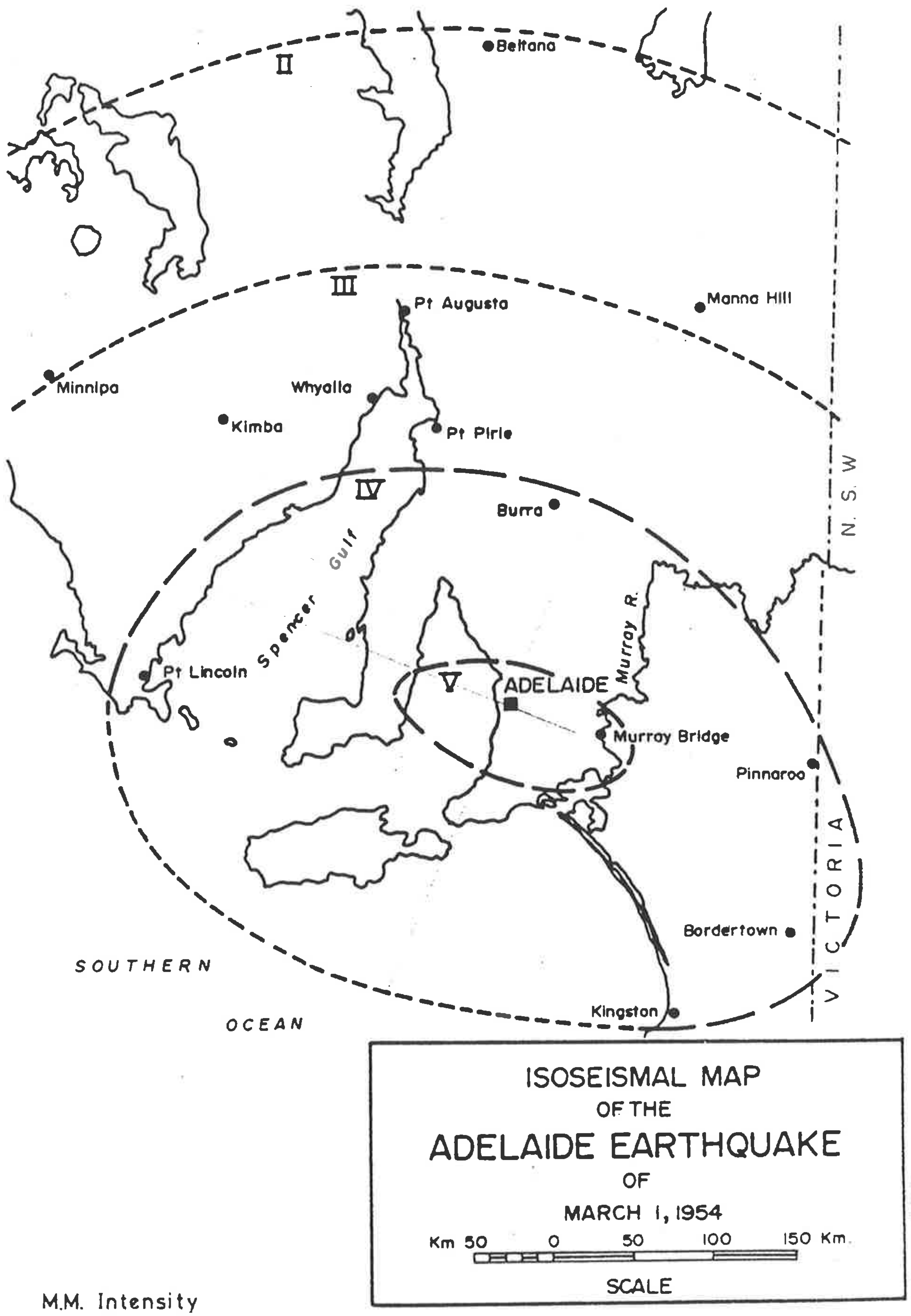


FIGURE 4.9 M_L = 5.25

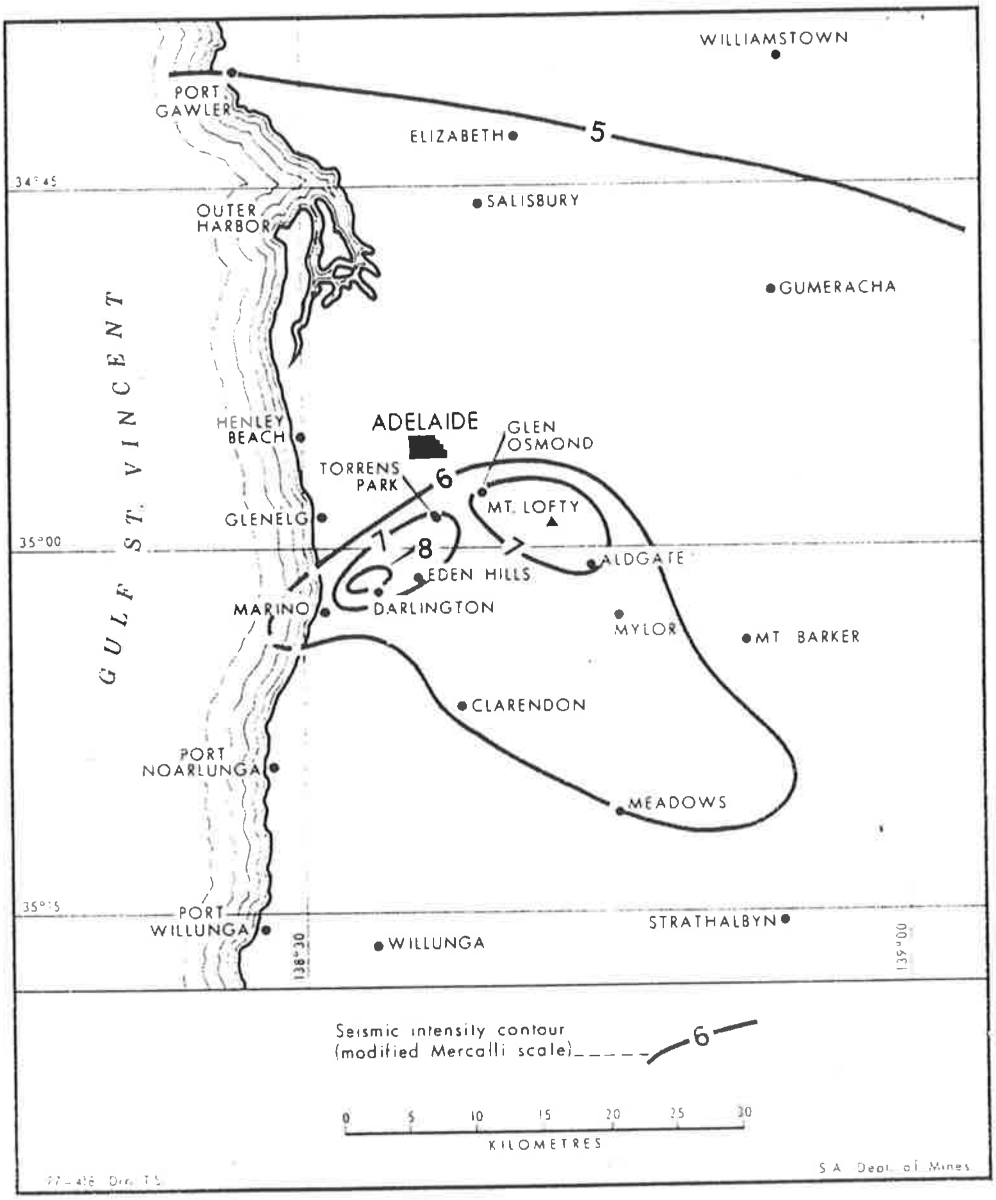


FIGURE 4.10 ISOSEISMAL MAP ADELAIDE EARTHQUAKE 1954

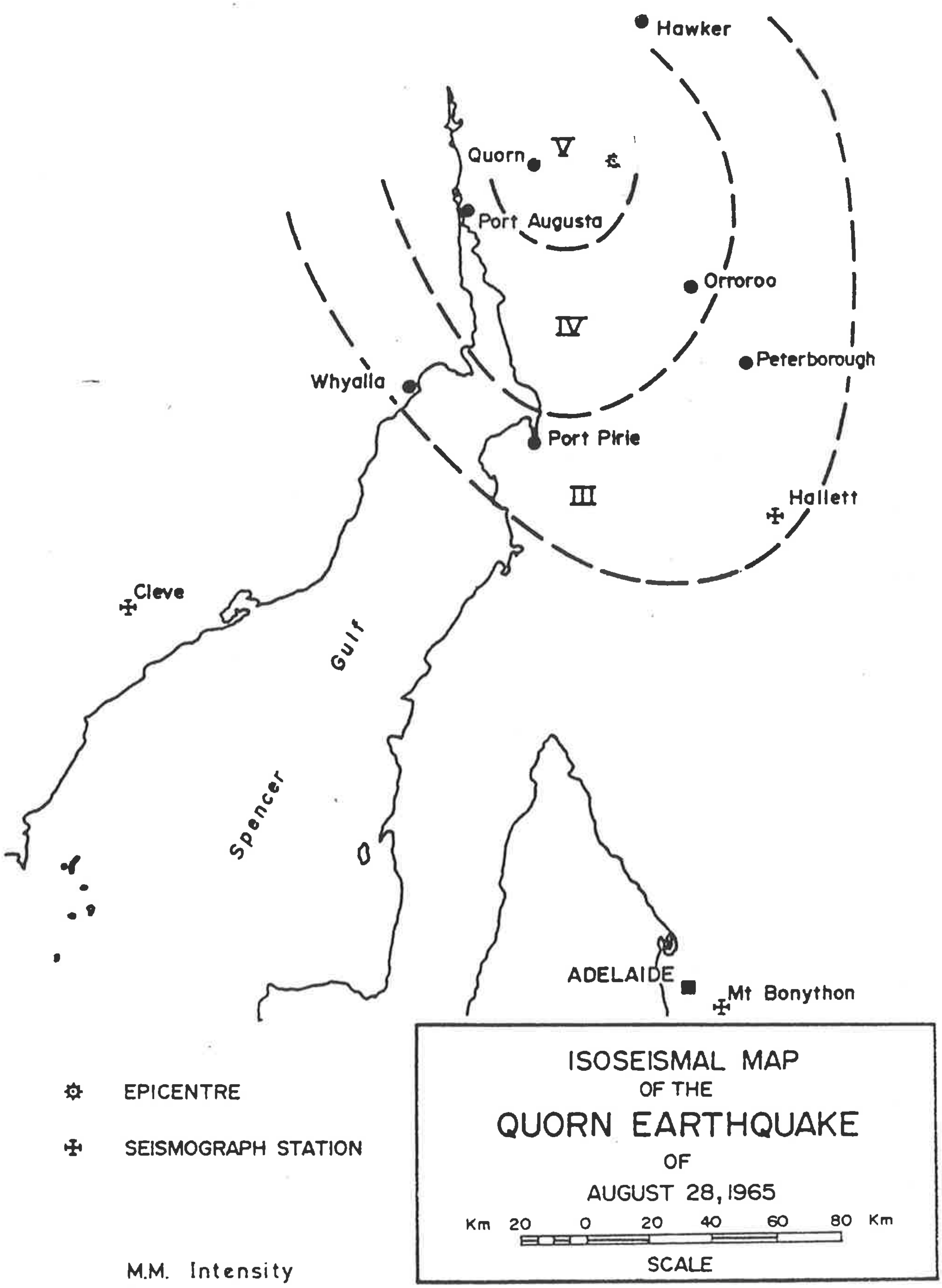


FIGURE 4.11 $M_L = 5.0$

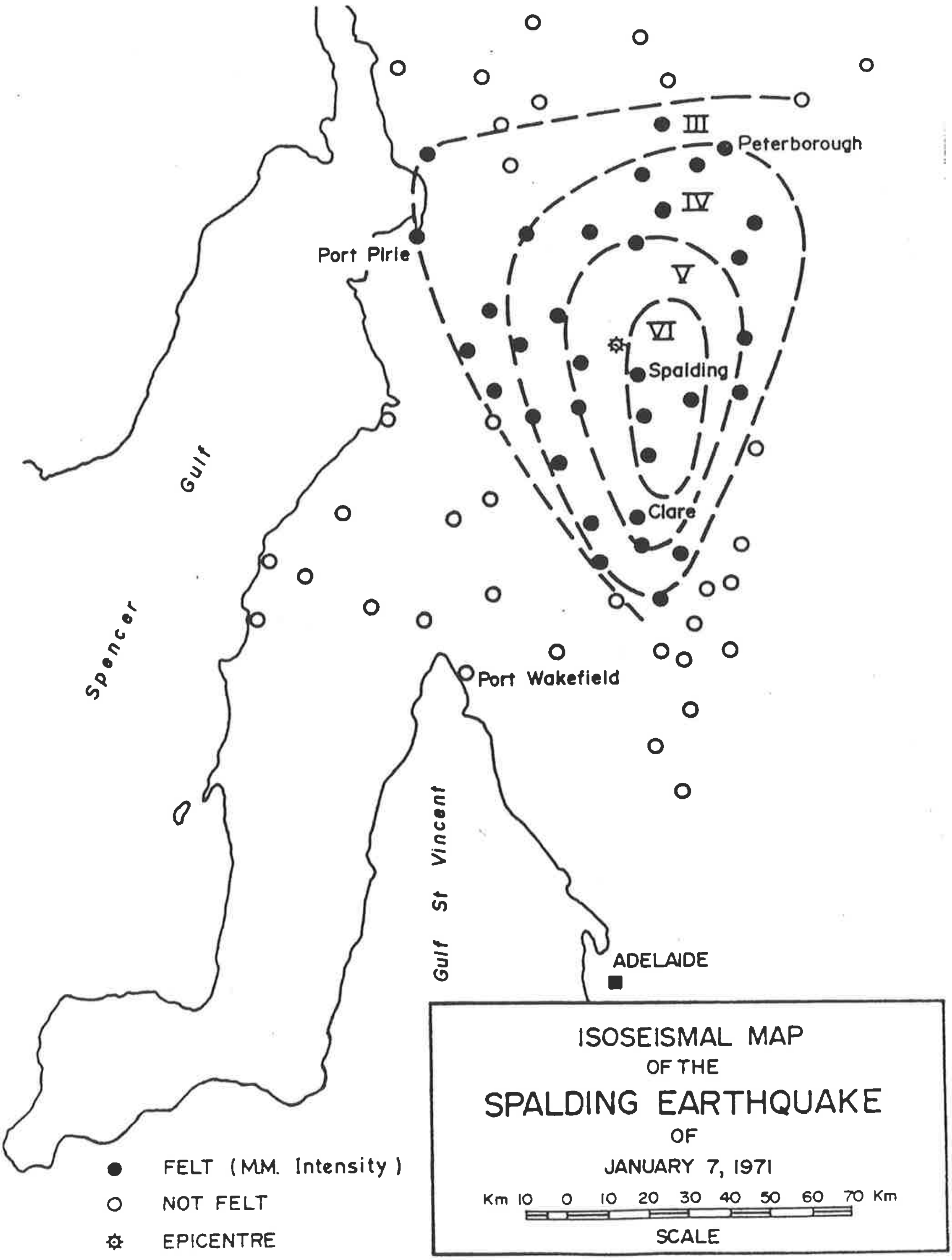


FIGURE 4.12 $M_L = 4.6$

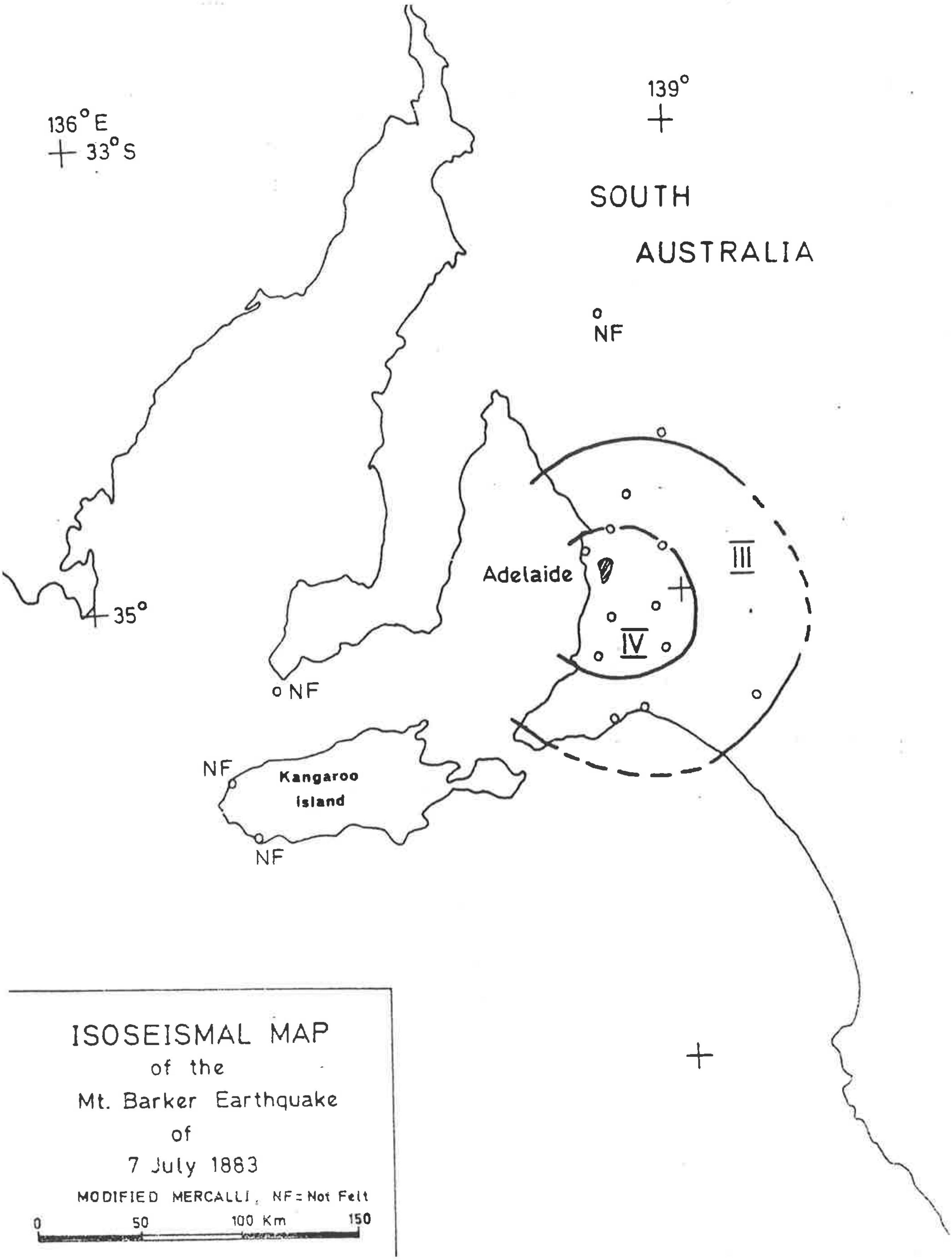


FIGURE 4.13 $M_L = 4.25$

Nonetheless McCue (1975) attempted to show how Esteva's equations (1973) could be justifiably used in South Australia.

Figures 4.21 and 4.18 show at Richter magnitude 7.5 and 5.0, respectively, the variations between the four equations used. McGuires equations and Esteva's equations agree fairly closely, but those of Hasegawa et al produce higher velocities than either McGuire or Esteva at 7.5 magnitude and lower velocities at 5.0 magnitude.

Figures 4.14 to 4.20 show the Modified Mercalli intensity data converted to velocities for the events for which there are isoseismals and the four equivalent attenuation equation estimated velocities.

Correlation between observed data and Esteva's expected velocities appears to be quite good for Kingston, Warooka and Adelaide events. The "straighter" relationship of McGuires and Hasegawa, Basham and Berry's equations, appear to give a less accurate picture of the shape of the observed data than does the more curved relation of Esteva. Of the other events of 5.0 or more, i.e. Robe (5.6) and Quorn (5.0), the observed data appears to fall between McGuire/ Esteva and Hasegawa, Basham and Berry, the Robe event data favouring the latter more than the former. The smallest events Spalding (4.6) and Mount Barker (4.25) again fall between McGuire/ Esteva and Hasegawa, Basham and Berry though the latter event appears to favour the former equation. Data is very scant for these low magnitude events and probably of little interest

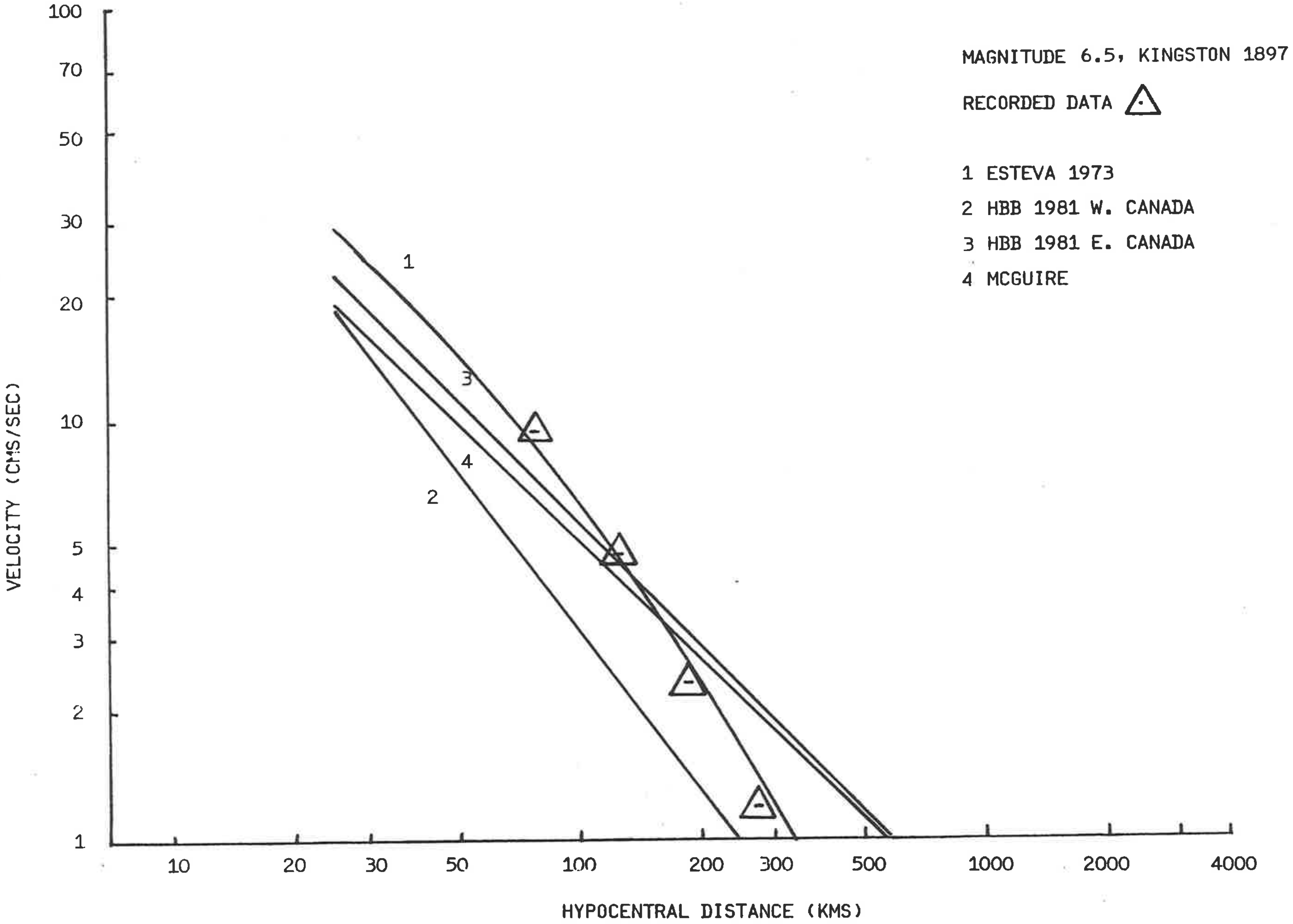


FIGURE 4.14 ATTENUATION M_L = 6.5

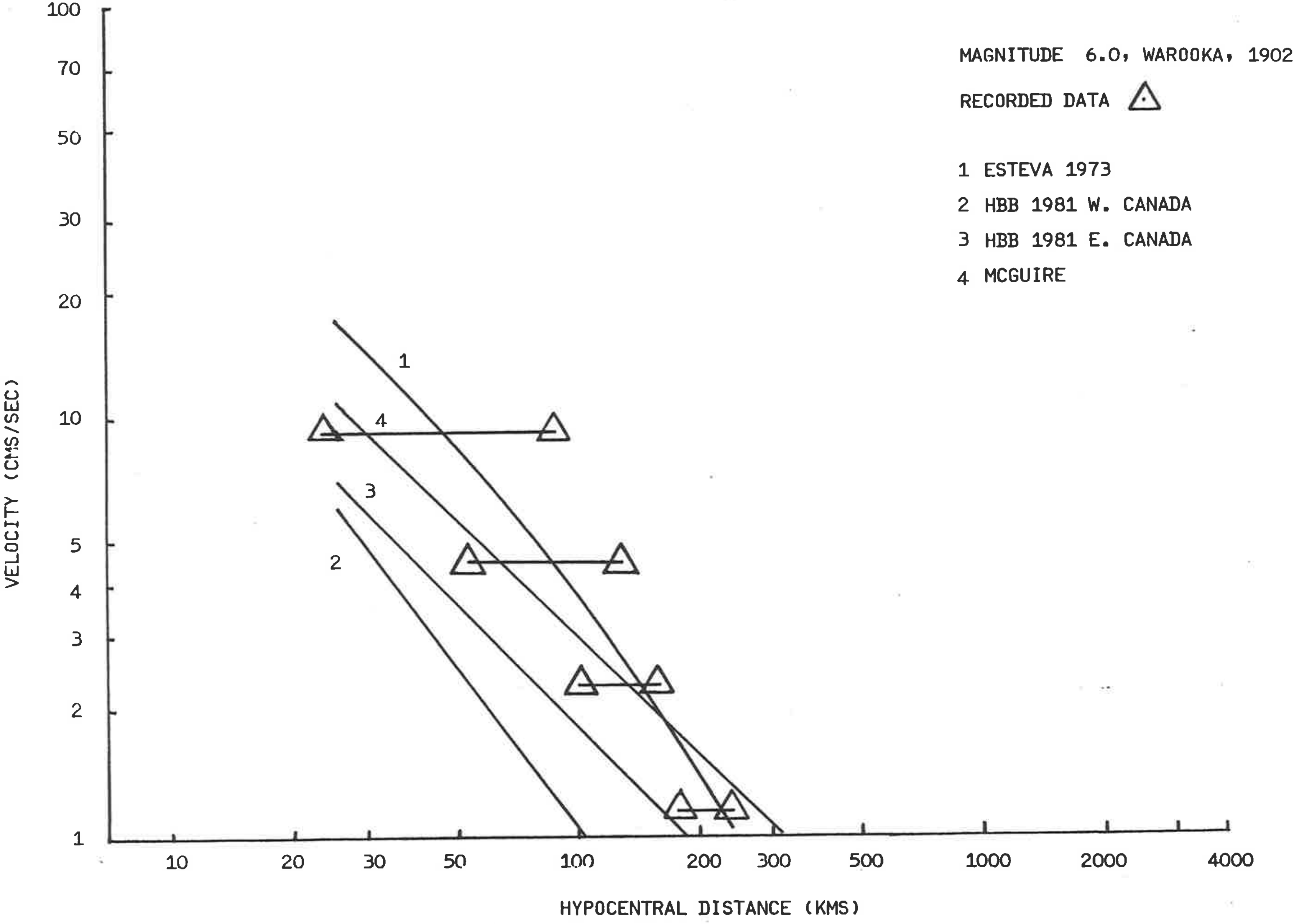


FIGURE 4.15 ATTENUATION M_L = 6.0

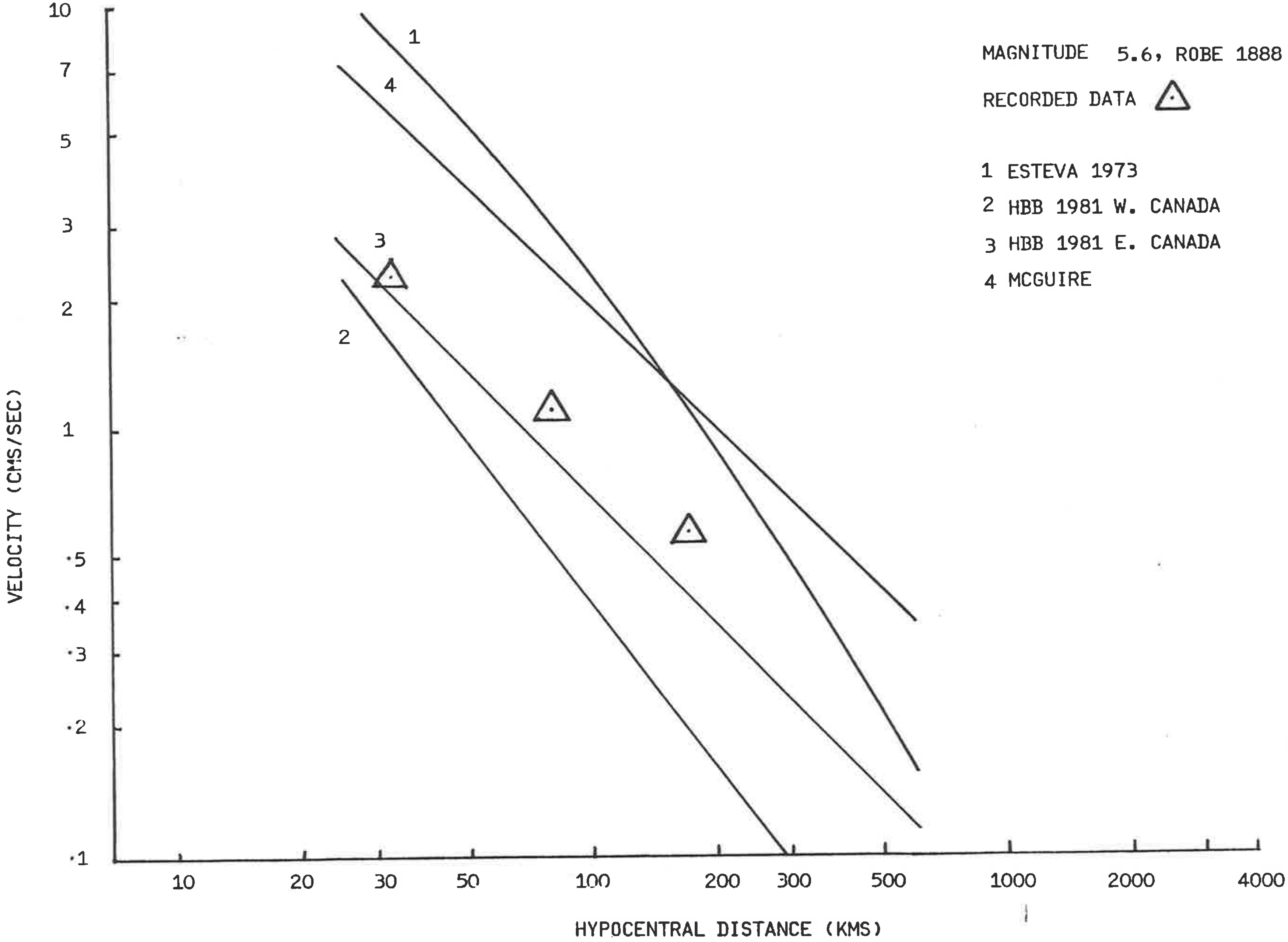


FIGURE 4.16 ATTENUATION M_L = 5.6

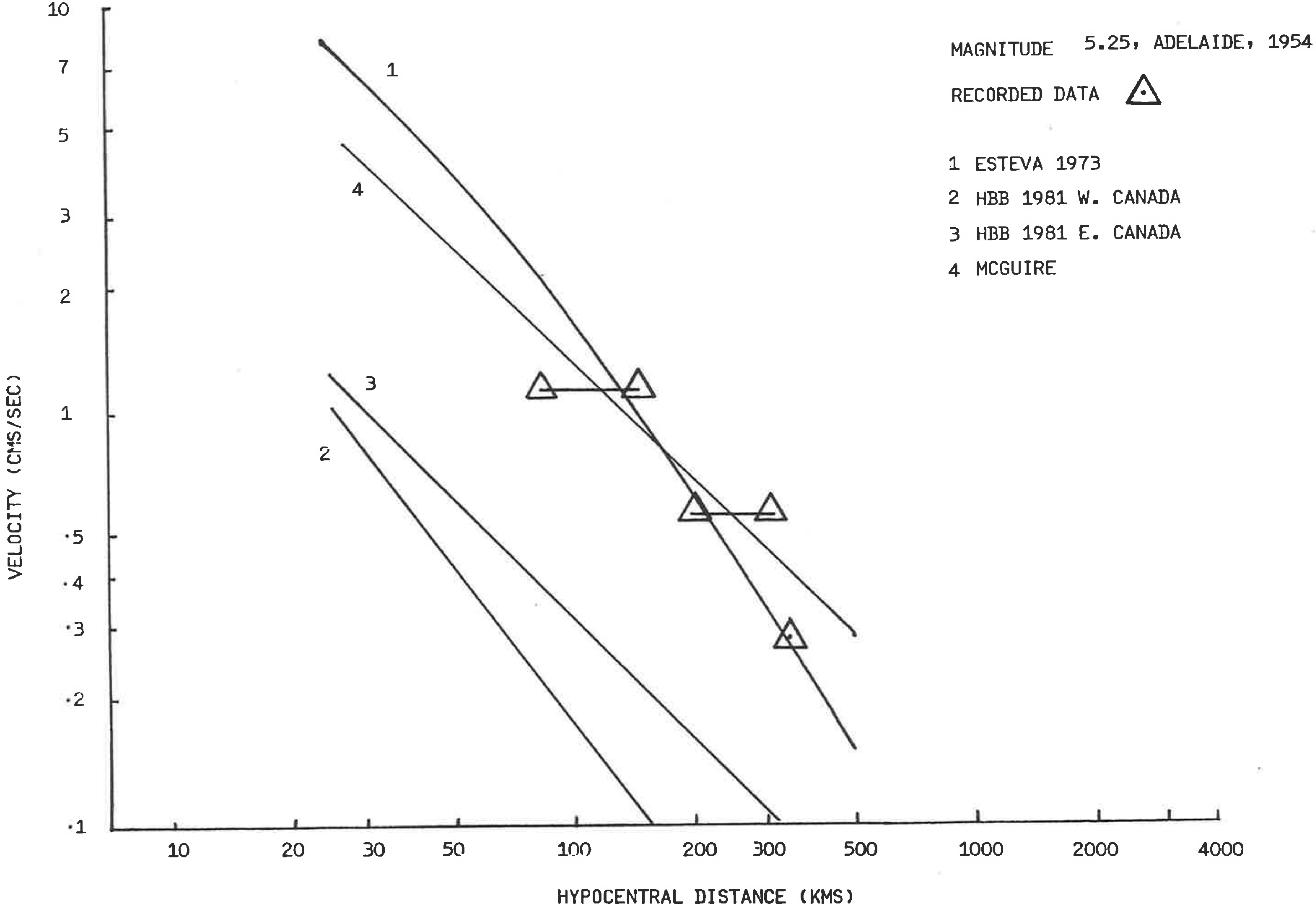


FIGURE 4.17 ATTENUATION M_L = 5.25

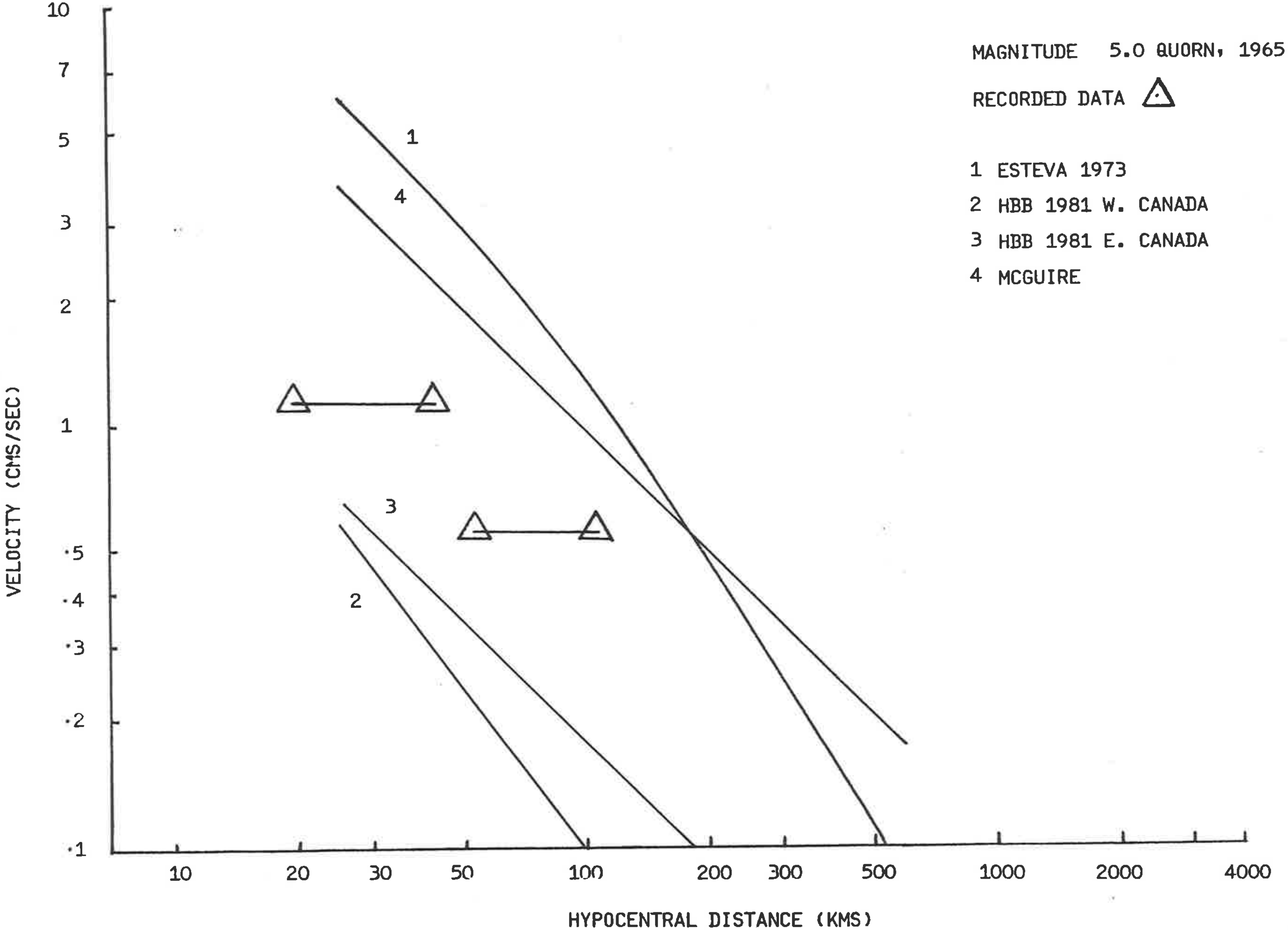


FIGURE 4.18 ATTENUATION M_L = 5.0

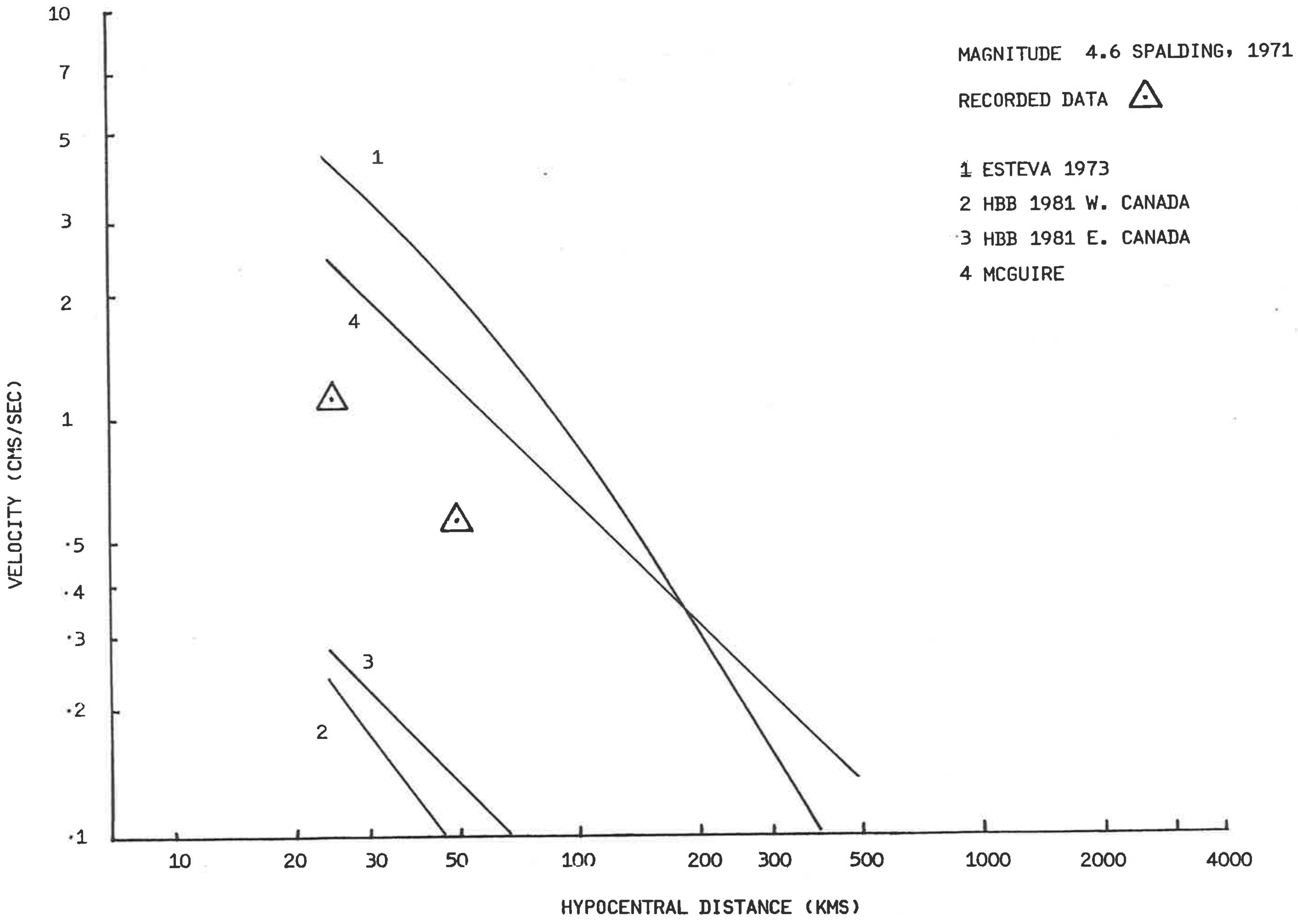


FIGURE 4.19 ATTENUATION M_L = 4.6

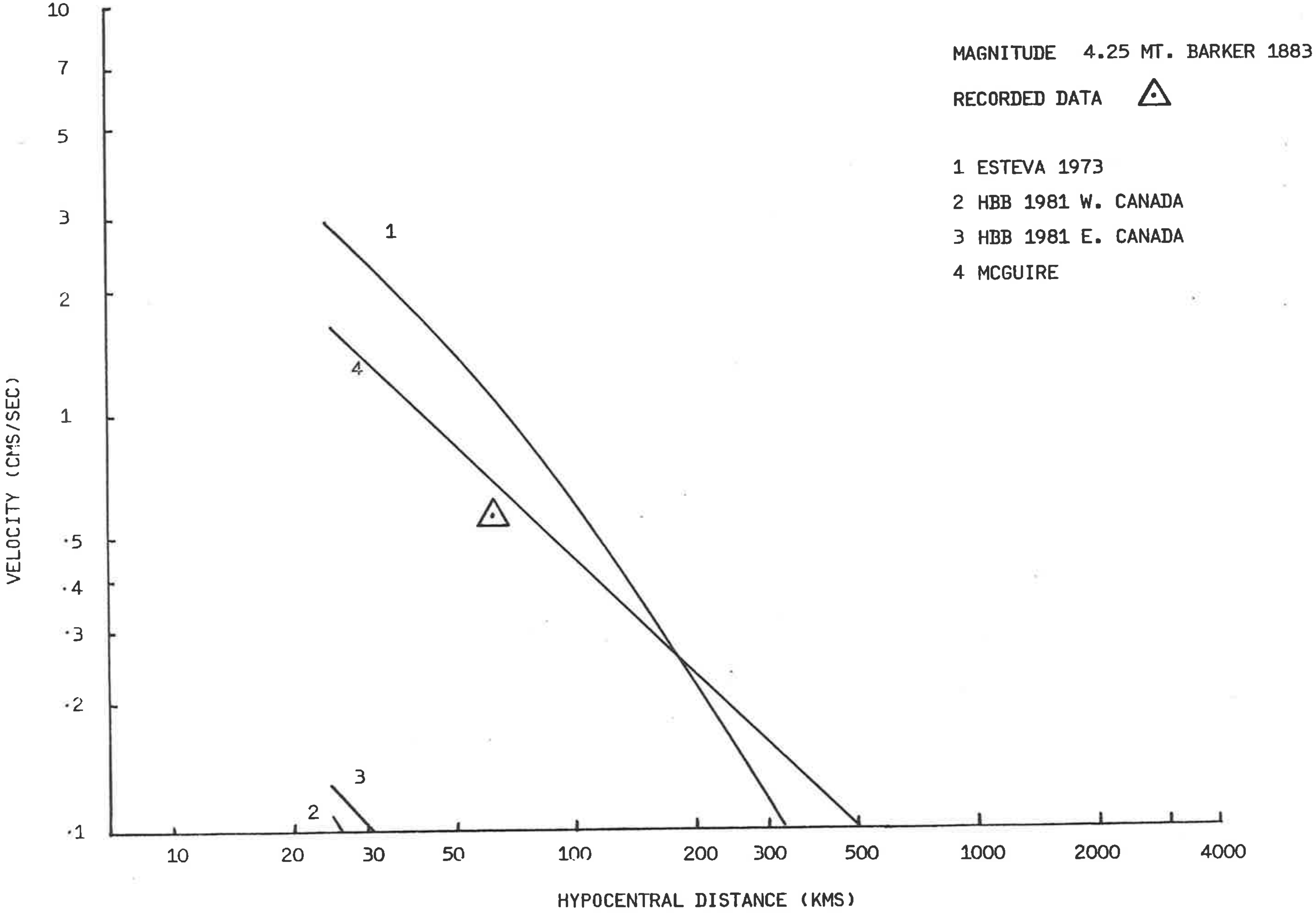


FIGURE 4.20 ATTENUATION M_L = 4.25

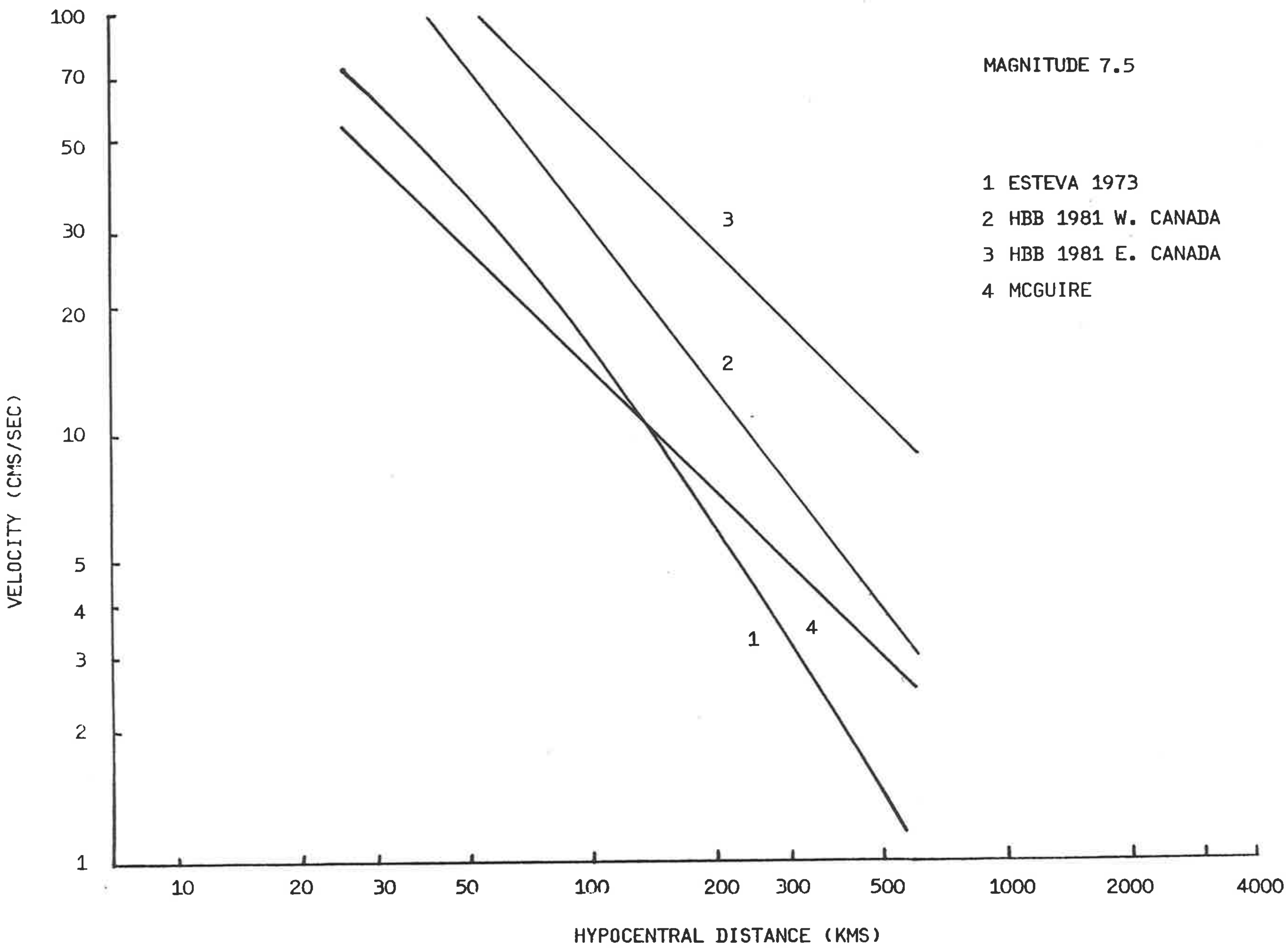


FIGURE 4.21 ATTENUATION M_L = 7.5

to a seismic risk analysis as velocities less than 5 cm/s are rarely of any consequence to structures (maximum observed data about 1 cm/s). So it appears that Esteva 1973 gives a good estimate of shape and a close estimate of velocity for larger events. Until further data is available his equation for velocity appears to be a good estimate. It is interesting to note that the use of McGuire's relationship for soil makes less than half a zone difference in assessment of risk when compared with that of Esteva (see Section 5).

Please note that no attempt has been made to use observed Modified Mercalli intensities to account for local soil conditions. It is known that considerable amplifications of ground motions can occur because of local ground conditions e.g. ridge amplification and resonance of deep soil deposits. Most of the isoseismal maps presented exhibit some evident distortion in the shapes of the isoseismals, probably a function of either amplification effects or the subjectivity of the intensity assessment. Figure 4.10 illustrates the variability of the observed data that can be noted and in that case the effects are probably also due to "near field" effects. It is a matter of some conjecture as to the exact shape of attenuation curves in the "near field" (within say 25 km of the source). Some observers maintain acceleration, velocities etc. increase in the near field as one approaches the source; others believe that they reached a plateau and yet others believe that they may decrease. Probably all assessments are valid and very much a function of the source mechanism and geometry of each event. For the purposes of this thesis, observations within 25 km of the source, "near field" effects, have been disregarded as the difficulties in obtaining good data and applying it are not warranted by the low probability* of being within the "near field" of an event.

*The probability of being within 25km of a structurally damaging event is estimated at about 1% per annum in the active areas of South Australia.

CHAPTER 5

5.1 Seismic Risk Program (ROSIE)

For the purposes of evaluating seismic risk at given sites the program ROSIE (Risk of Seismic Incident Eventuating) was used. This program was originally prepared by the writer for the purposes of seismic risk analysis at several sites in South Australia (e.g. Port Augusta, Stony Point, Port Stanvac etc.). It was written in general terms so that it was as flexible in application as practically reasonable and could be used for other locations too. The program was modified and extended for the purposes of this thesis.

The program now accepts historical earthquake data in the standard form produced by the Bureau of Mineral Resources Geology and Geophysics.

The following information is used as input

(a) a defined source basin within which events will be considered.

(b) a defined maximum possible magnitude of event.

(c) a defined period of events to be considered.

(d) maximum and minimum events to be used for recurrence definition.

(e) a class interval to be used for recurrence definition.

(f) co-ordinates of the site at which risk is to be assessed.

(g) a seismic attenuation equation to be used (a selection can be made from several in velocity or acceleration).

(h) a threshold event for which a return period is required.

(i) a subsource pixel* size and an event depth if required.

The program then evaluates

(a) the number of historical data points within the basin defined.

(b) the events within the defined class ranges are then printed out and basic data on recurrence calculated.

(c) curve fitting is then done using a weighted linear regression on log normal data and the derived relation is output.

(d) curve fitting is also done using the method of maximum likelihood assuming a Poissonean distribution of events; the derived relation is also output.

(e) method (d) recurrence derivation is converted to a form comparable with (c).

(f) seismic risk is assessed using the derived relationships assuming "local" activity within the source basin area.

(g) finally seismic risk is assessed using only the method (c) and assuming "uniform" source basin activity.

The seismic risk assessed in (f) and (g) is performed by using subsource pixels throughout the source basin area.

* a pixel is an elemental subsource which is used to integrate throughout the defined source; generally a 0.1° square.

The differences between "local" activity analysis and "uniform" activity analysis are explained in section 4.2. Mathematically, if

$p\ (M, A_B)$ = probability of an event of magnitude M or greater occurring in a source basin area A_B.

$p\ (M, A_P)$ = probability of an event of magnitude M or greater occurring in a pixel of area Ap.

n = number of pixels of area Ap in a source basin of area A_B.

N_T = number of historic events recorded in source basin of area A_B over a given era T years.

K_{Ti} = number of historic events recorded in the ith pixel of area Ap over a given era T years.

then for "uniform" activity

$$p\ (M, Ap)\ \text{uniform} = p\ (M, A_B)\ \frac{Ap}{A_B}$$

and for "local" activity

$$b\ (M, Ap)\ \text{local} = p\ (M, A_B)\ \frac{K_{Ti}}{N_T}$$

Clearly the latter method requires more computing time as $\frac{Ap}{A_B}$ is a constant, $\frac{1}{n}$, and K_{Ti} is a variable, but the benefits of more rational analysis justify this marginal extra expenditure.

The program can be used to consider multiple source basins contributing to risk at a given site.

Two sites were selected for analysis for this study, one of higher risk (by South Australian Standards) than average and one of lower risk. They were Port Augusta (at the head of Spencer Gulf in South Australia) and Adelaide, respectively.

5.2 Seismic Risk Analysis at a higher risk site

The site selected is at 137.783°E 32.549°S at Port Augusta, South Australia.

Several trial analyses were performed to attempt to assess likely errors and the following basic parameters were varied within justifiable reason.

(a) Spatial distribution of events
(b) Rate of recurrence
(c) Maximum possible magnitude
(d) Attenuation relationships
(e) Temporal data sets

The results of these variations are shown in appendix C.

From the results the following conclusions may be drawn:

(a) varying the basin area has little effect on the assessment risk (note a "local" analysis has been used here (see section 4.2 for explanation of "local")).

(b) Using different techniques for finding the recurrence relationship has a small effect on assessed risk.

(c) varying the maximum possible magnitude limit substantially has little effect except for long return period events.

(d) varying the attenuation equation quite radically has a substantial effect on the assessed risk.

(e) varying the era of data has a substantial effect on the assessed risk.

5.3 Seismic Risk Analysis at a lower risk site

The site selected is at 138.600°E 34.933°S at Adelaide, South Australia.

Again, as was done for the high risk site at Port Augusta in section 5.2, the following basic parameters were varied within justifiable reason

(a) Spatial distribution of events
(b) Rate of recurrence
(c) Maximum possible magnitude
(d) Attenuation relationships
(e) Temporal data sets

The results of these variations are shown in Appendix C.

From the results the following conclusions can be drawn:

(a) varying the basin area has a substantial effect on the assessed risk (note a "uniform" analysis has been used here (see section 4.2 for explanation of "uniform")).

(b) using different techniques for finding the recurrence relationship has a small effect on assessed risk.

(c) varying the maximum possible magnitude limit substantially has little effect except for long return period events.

(d) varying the attenuation equation quite radically has a substantial effect on the assessed risk.

(e) varying the period of data has a substantial effect on the assessed risk.

5.4 Commentary on risk analysis

The basin area assumed for the Adelaide site seismic risk analysis is obviously critical to the result obtained for risk assessment. The analysis assumes uniform activity in this case as the local activity gives a lower risk which would probably be unrealistically low as the larger more damaging events are more uniformly distributed over the geosyncline than the smaller events, upon which the local activity analysis leans more heavily. Because of the assumption of uniform activity, the basin area selected becomes more critical. It is evident in this case that, by using the whole of the Adelaide Geosyncline, the seismic risk at Adelaide is raised compared with an analysis using only the southern part of the geosyncline. The justifications for using the whole Adelaide Geosyncline are that

(a) the geology indicates such a distribution

(b) the distribution of larger seismic events (Figure 4.3) appears to extend over the whole of the Adelaide Geosyncline

(c) a historical analysis of seismic ground motions to date indicates a seismic zoning compatible with that obtained by using the Adelaide Geosyncline (see Appendix D).

(d) UBC (1979) recommends caution when assessing seismic risk at a site where there is a known faulting system (the Burnside-Eden fault is believed to have caused the 1954 Adelaide event).

As more data becomes available the differences in derived recurrence relationships will probably reduce as the statistical data base increases. Varying maximum magnitude has little effect for return periods of normal interest.

Varying the attenuation equations shows the kind of effect that can occur in assessed risk, but it seems that Esteva 1973 gives the best fit to available data (see section 4.4) and therefore the effects of any defects in attenuation knowledge may be less than the range shown on Figures C4 and C9.

Varying the era of data shows how little reliable data is available at present in South Australia: this situation will only improve with time. The significance of using data sets 1966-1973½ and 1973½-1979 is that the analysis by McCue (1975) used data up to 1973½ (actually July 31st 1973) and the division used shows the effects of the newer data on risk analysis. The data 1966-1979 is the best data that is currently available.

CHAPTER 6 COMPARISON WITH EXISTING ANALYSES

6.1 Existing Seismic Risk Analyses

There have been several risk assessments made to date in South Australia.

The following have been examined briefly

(a) McCue, 1975

(b) McEwin, Underwood and Denham, 1976

(c) NAASRA - 1976, Bridge Code

(d) Earthquake Code, AS 2121-1979

(e) Stewart, 1981

Analysis (a) McCue, 1975, examined seismic risk in South Australia and examined all historic data, geology, temporal variations, etc. to produce what has probably been the most thorough examination of seismicity in South Australia. Unfortunately the analysis was hampered by a lack of duration of data. The best, most reliable data had been recorded then for only 7½ years. Analysis (b) McEwin, Underwood and Denham, 1976, attempted to zone the whole of Australia using a program that took 0.5 degree squares throughout the active areas of the continent, assessed recurrence within each square and then assessed the risk at each 0.5° square using all other 0.5° squares as sources. This was a bold effort which gave tolerable results to enable areas of higher risk to be assessed. Unfortunately due to the blind way in which 0.5° square had to

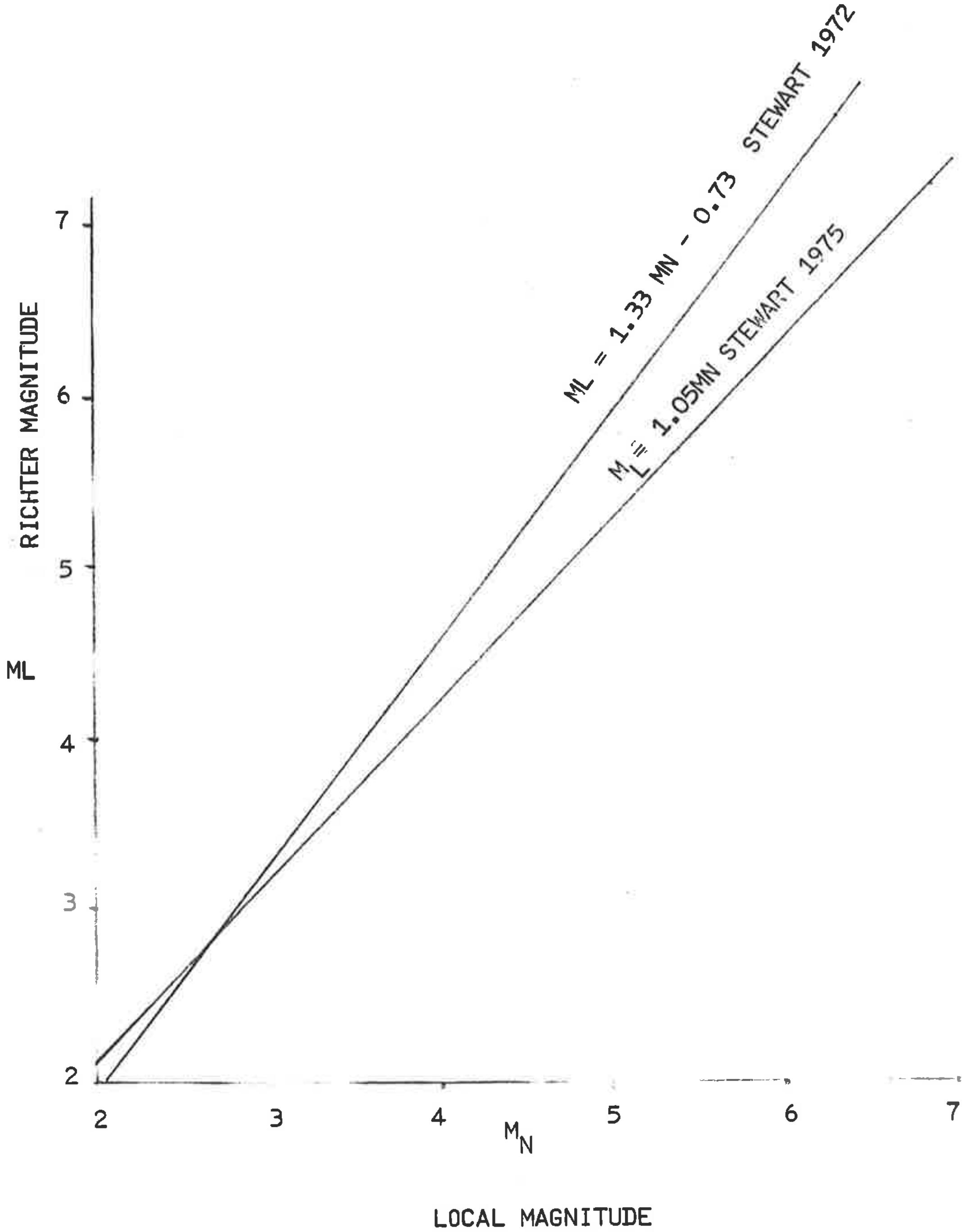


FIGURE 6.1 LOCAL TO RICHTER MAGNITUDE CONVERSIONS

be used to take advantage of the method, no geological data was taken into account. Some recurrence relationships inevitably had very few data points used in their derivation and hence could be inaccurate. Seismic trends could be seen from this analysis however.

Assessment (c) NAASRA - 1976, Bridge Code, took McCue's 1975 analysis and used that virtually unabridged.

Assessment (d) Earthquake Code AS 2121-1979, looked at analyses (a) and (b) and modified them where expert technical opinion felt errors had crept in due to either method of assessment or shortage of data duration.

Analysis (e) Stewart, 1981, was done using the seismic moment method and a Cornell analysis (methods of a and b are essentially Cornell analyses) and a modified data set. The major reason for it giving lower zonings appears to be due to the latter modified data (see Figure 6.1). Stewart in 1972 in his Ph.D. thesis had derived a local magnitude to Richter magnitude conversion scale for South Australia. In 1975 he published another conversion scale (Stewart 1975) which was based on data from local magnitude 1.5 to 3.5. There was an error in the original scale, Stewart (1972) which was known but nonetheless the later scale was not adopted. The reasoning was that the proposed new scale (1975) was not proven and appeared to give results that were incompatible with those found with other similar instruments used overseas. (Benioff vertical component Seismometers are mostly used). Also the data set on which the

1975 scale was based was very small in number of events and magnitude. The late Dr. Sutton of the University of Adelaide amongst others recommended continued use of the 1972 conversion as being a better estimate until such time as a better scale could be derived. McGregor and Ripper (1976) examined the conversion scales in some detail and concluded though no perfect conversion existed, Stewart (1975) would be acceptable for magnitude 1.5 to 3.5 and Stewart (1972) for greater magnitudes. Stewart (1972) also gave very similar results to Stewart (1975) in the range 1.5 to 3.5. Subsequently the Bureau of Mineral Resources Geology and Geophysics continued to publish data using the 1972 scale. This is the data scale used by assessments (a) to (d) inclusive and within this thesis generally though Figure 6.2 shows how the Port Augusta site risk assessment changes if Stewart (1975) were used.

Appendix D attempts to relate historic data to a seismic risk assessment for Adelaide and this appears to reinforce the Zone 1 assessment of Rosie using Stewart (1972) conversion.

Additionally if the Stewart (1975) magnitude conversion formula is used and the recurrence relation derived is compared with the historic data of Figure 4.4 it fits very poorly in comparison with the 1972 conversion.

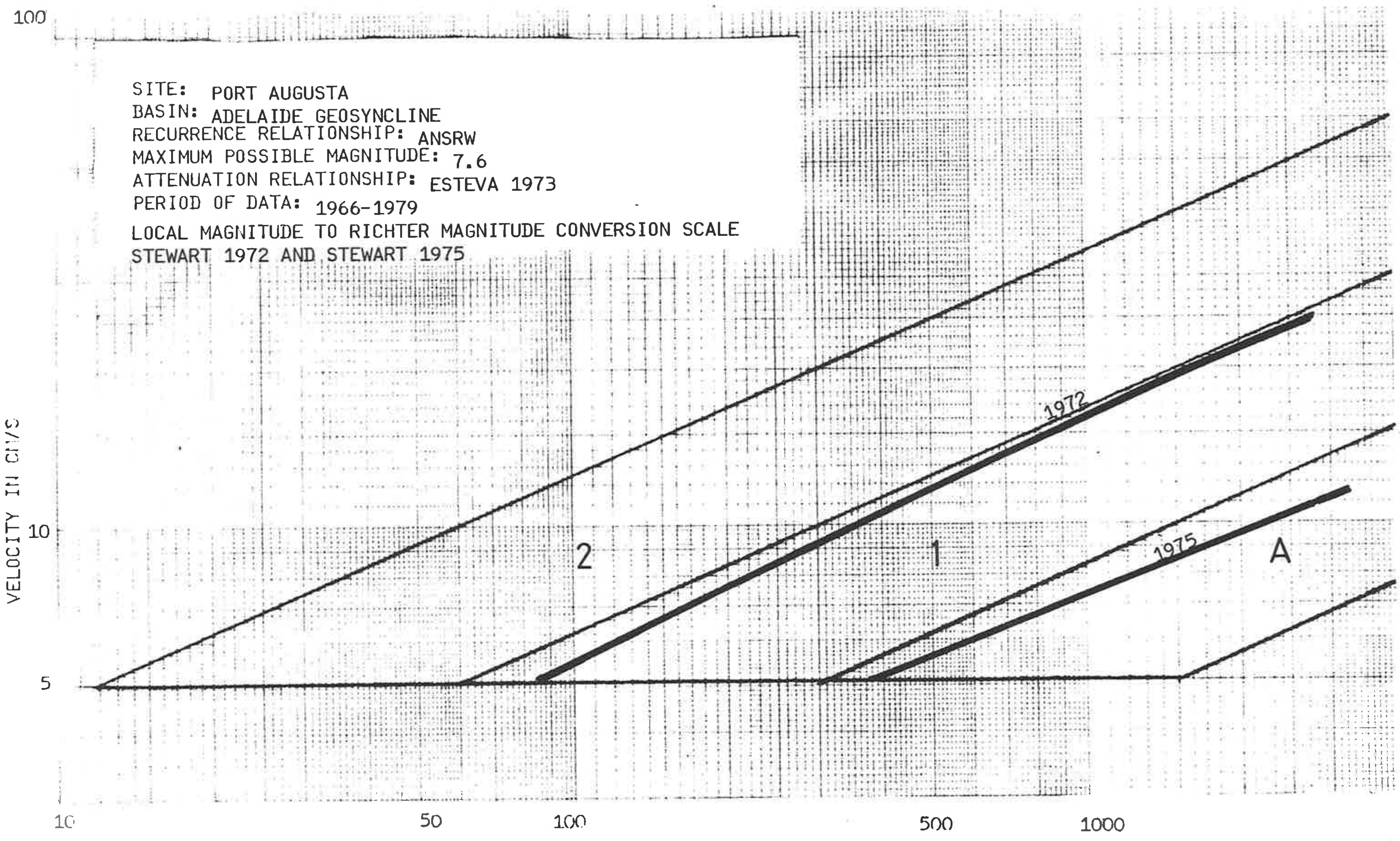

SITE: PORT AUGUSTA
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: 1966-1979
LOCAL MAGNITUDE TO RICHTER MAGNITUDE CONVERSION SCALE
STEWART 1972 AND STEWART 1975
100
10
5
VELOCITY IN CM/S
2
1
A
1972
1975
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE 6.2

6.2 Comparison of analyses

Comparison is made between only the analyses (a), (d) and (e) as well as those shown in section 5.

Analysis	Site at Port Augusta	Site at Adelaide
(a) McCue, 1975	Zone 2	Zone 1
(d) Earthquake Code AS2121-1979	Zone 1	Zone 1
(e) Stewart, 1981	Zone 1	Zone 1
Rosie, 1982	Zone 1	Zone 1

The Zones used are those of AS2121-1979. The current risk analysis of McCue in 1975 is the only analysis that appears to differ from the general zone 1 rating of both of these sites. This is due to the short record of data that was used by McCue (then the only available data) influencing the assessed risk (see Figures C5 and C10). An educated modification of the assessed risk by the expert Seismic Zoning Sub-Committee of AS 2121-1979 reduced the zoning for the SAA Earthquake Code. To date this modification has been justified and current risk estimates agree with the Code appraisal.

CHAPTER 7 - CONCLUSION

The reasons for performing seismic hazard assessment have been briefly discussed. The three basic components of the seismic hazard assessment are:

(i) spatial distribution of events

(ii) recurrence of events within the source

(iii) attenuation of effects from the source

Examination of the components show that

(i) the spatial distribution of the events must take into account the geology and the distribution of the most damaging events to be rational

(ii) the recurrence relationship derivation has only a small effect on the assessed risk and this effect will diminish as more data are collected

(iii) the attenuation relationship commonly used (Esteva, 1973) though based on scant data is an adequate fit to the data available. Reasonable variations in this equation are unlikely to have more than a minor effect on the assessed risk.

Currently it is unclear how to convert local magnitude to a magnitude scale with a known attenuation equation.

Two local-to-Richter magnitude conversion scales have been proposed recently (Stewart 1972 and Stewart 1975) and the older conversion has been preferred to date (see Section 6.1 for details). Unfortunately, this situation is unlikely to improve immediately as it is proposed to adopt a duration magnitude scale system for future seismic records. This will entail establishment of a further conversion scale or a duration magnitude related attenuation scale. It was proposed until recently to check the existing conversion formulae by using a classical Wood-Anderson seismometer (as Richter used) in conjunction with the usual vertical component Berioff machines at each recording station. However, this will not now go ahead.

Meanwhile the construction industry has to build structures in South Australia and can only act on the best information available which appears to favour, from a simple historic analysis viewpoint, the seismic conversion scale of Stewart, (1972).

As more data become available,attenuation, recurrence and spatial distribution assumptions can be re-checked and more accurate current seismic hazard assessments will be possible.

REFERENCES

Ambraseys, N.N. (1971). Value of Historical Records of Earthquakes. Nature, Vol. 232, August pp 375-381.

Basham, P.W., Weichert, D.H. and Berry M.J. (1979). Assessment of Seismic Risk in Eastern Canada. Bull. Seis. Soc. of Am., Vol. 69, No. 5, pp 1567-1602, October.

Burton, P.W. (1977). Assessment of Seismic Hazard in the U.K. Natural Environment Research Council, Institute of Geological Sciences, Edinburgh.

Burton, P.W. (1978). The IGS file of seismic activity and its use for hazard assessment. Natural Environment Research Council, Institute of Geological Sciences, Edinburgh.

Burton, P.W. (1979). Seismic Risk in Southern Europe through to India examined using Gumbel's third distribution of extreme values. Geophys. J.R. astr. Soc. (1979) 59, 249-280.

Campbell, K.W. et al (1979). Design Earthquake Magnitude. Based on a damage threshold level Abstracts 71st Annual Meeting, Seis. Soc. Am.

Campbell, K.W. (1981). Near Source Attenuation of Peak Horizontal Acceleration. Bull. Seis. Soc. Am., Vol. 71, No. 6, pp2039-2079, December.

Chandra, U. (1979). Attenuation of Intensities in the United States. Bull. Seis. Soc. Am., Vol. 69, No. 6, pp2003-2024, December.

Chaplow, R. (1977). Seismic Risk at the Northern Power Station, South Australia (unpublished).

Cornell, C.A. (1969). Engineering Seismic Risk Analysis. Bull. Seis. Soc. Am. Vol. 68, Pt. 2, pp 1583-1606.

Donovan, N.C. and Bornstein, A.E. (1978). Uncertainties in Seismic Risk Procedures. Journal of the Am. Soc. Civil Eng. GT 7, pp869-887, July.

Dowrick, D.J. (1981). Earthquake Risk and Design Ground Motions in the U.K. Offshore Area. Proc. Inst. Civ. Engrs., U.K. Part 2, 1981, 71, June, 305-321.

Duke C.M., Eguchi R.T., Campbell K.W. and Chow A.W. (1976). Effects of site on Ground Motions in San Fernando Earthquake. Report No. UCLA-ENG-7688, University of California, Los Angeles, August.

Espinosa, A.F. and Husid, R. (1979). Some Inconistencies of the Modified Mercalli Intensity Scale: A Case Study. The Seis. Soc. Am., Eastern Section. Abstracts 71st Annual Meeting.

Esteva, R.L. and Villaverde, R. (1973). Seismic Risk, Design Spectra and Structural Reliability, Proceedings 5th World Conference on Earthquake Engineering, Rome pp 2586-2597.

Gumbel, E.J. (1958). Statistics of Extremes. New York and London: Columbia University Press.

Gupta, I.N. (1976). Attenuation of Intensities Based on Isoseismals of Earthquakes in Central United States. Seis. Soc. Am., Earthquake Notes, Vol. 47, No. 3, pp 13-20, July.

Gupta, I.N. (1980). A Note on Correlation of Modified Mercalli Intensity with Peaks of For-Field Ground Motion. Bull. Seis. Soc. Am., Vol. 70, No. 3, pp 925-932, June.

Gutenberg, B. and Richter, C.F. (1965). Seismicity of the Earth, Hafner, New York and London.

Gutenberg, B. and Richter, C.F. (1956). Earthquake Magnitude, Intensity, Energy and Acceleration (Second Paper). Bull. Seis. Soc. Am., Vol. 46, No. 2, April pp 143-145.

Hasegawa, H.S., Basham, P.W. and Berry, M.J. (1981). Attenuation Relations for Strong Seismic Ground Motion in Canada. Bull. Seis. Soc. Am., Vol. 71, No. 6, pp 1943-1962, December.

Herrman, R.B. (1977). Recurrence Relations. Seis. Soc. Am., Earthquake Notes, Vol. 48, Nos. 1-2, pp 47-49, January.

Housner, G.W. (1973). The Role of Earthquake Ground Motions in Earthquake Engineering. Proc. 5th World Conf. on Earthquake Engineering, Rome, 1973.

Idriss, I.M. (1978). Characteristics of Ground Motions. Soil Dynamics in Earthquake Engineering Conference, 1978, Pasadena, California.

Johnson, J.J. and Kennedy, R.P. (1979). Earthquake Response of Nuclear Power Facilities.

Knopoff, L. and Kagan, Y. (1977). Analysis of the theory of extreme values as applied to seismic problems. J. Geophys. Res. 82, 5647-5657.

Lew, H.S., Leyendecker, E.V. and Dikkers, R.D. (1971). Engineering Aspects of the 1971 San Fernando Earthquake. Building Science Series 40, 419 pages, December, U.S. Govt. Printing Office, Stock No. 0303-0940.

Lilwall, R.C. (1976). Seismicity and seismic hazard in Britain. Institute of Geological Sciences, Edinburgh Seismological Bulletin No. 4.

Lomnitz, C. (1980). Comments on "Canadian Methodologies of Probalistic Seismic Risk Estimation" by D.H. Weichert and W.G. Milne. Bull. Seis. Soc. Am., Vol 70, No. 3, p933, June.

Long, T.L. (1976). Short-period Surface-wave Attenuation and Intensities in the Georgia-South Carolina Piedmont Province. Seis. Soc. Am., Earthquake Notes, Vol. 47, No. 3, July-September pp 3-11.

Makjanic, B (1980). On the frequency distribution of earthquake magnitude and intensity. Bull. Seis. Soc. Am., Vol. 70, No. 6, pp 2253-2260, December.

Makropoulos, K.C. (1978). The Statistics of Lerze Earthquake Magnitude and an Evaluation of Greek Seismicity. PhD Thesis, University of Edinburgh, 1978.

McCue, K.F. (1973). Report on the seismicity of Western Australia Part I and II. Imperial College, London.

McCue, K.F. (1975). Seismicity and Seismic Risk in South Australia. The University of Adelaide, Department of Physics, ADP 137, July.

McCue, K.F. (1977). Seismic risk in Eastern Australia. The University of Adelaide Department of Physics, ADP 153.

McEwin, A., Underwood, R. and Denham, D. (1976). Earthquake Risk in Australia. Bureau of Mineral Resources Geology and Geophysics, Journal of Australian Geology and Geophysics 1 (1), March, pp 15-21.

McGregor, P.M. and Ripper, I.D. (1976), Notes on Earthquake Magnitude Scales. Bureau of Mineral Resources Geology and Geophysics Record 1976/56.

McGuire, R.K. (1974). Seismic Structural Response Risk Analysis, Incorporating Peak Response Regressions on Earthquake Magnitude and Distance. Massachusetts Institute of Technology, Cambridge, Massachusetts, Department of Civil Engineering, Research Report, R74-51.

McGuire, R.K. (1978). Seismic Ground Motion Parameter Relations. Journal of the Geotechnical Division, ASCE, Vol. 104, No. GT4, April, pp 481-490.

McGuire, R.K. and Barnhard, T.P. (1981). Effects of Temporal Variations in Seismicity on Seismic Hazard. Bull. Seis. Soc. Am., Vol. 71, No. 1, pp 321-334, February.

Milne, W.G. and Davenport, A.G. (1969). Distribution of Earthquake Risk in Canada. Bull. Seis. Soc. Am., Vol. 59, Pt. 2, pp 729-754.

Newmark, N.M. and Rosenblueth, E. (1971). Fundamentals of Earthquake Engineering, Prentice Hall.

Nuttli, O.W. and Zollweg, J.E. (1974). The Relation Between Felt Area and Magnitude for Central United States Earthquakes. Bull. Seis. Soc. Am., Vol. 64, pt. 1, pp 73-78.

Peek, R. (1980). Estimation of Seismic Risk for New Zealand. A seismicity model and Preliminary Design Spectra. Department of Civil Engineering University of Canterbury, Christchurch, N.Z. Research Report 80/21.

Richter, C.F. (1958). Elementary Seismology. Freeman and Co., San Francisco.

Schaefer, S.F. and Herrmann, R.B. (1977). Seismic Risk Analysis applied to the Central United States. Seis. Soc. Am. Earthquake Notes, Vol. 48, No. 4, Oct. - Dec. 1977 pp 35-41.

Selby, J. (1979). Earthquakes in South Australia. S.A. Department of Mines and Energy, Mineral Information Series.

Smith, R.S. and McEwin, A.J. (1980) Earthquake Accelerograms at Oolong, N.S.W. BMR Journal.

Stewart, I.C.F. (1972). Micro earthquakes and Tectonics of South Australia. PhD Thesis University of Adelaide.

Stewart, I.C.F. and Sutton D.J. and Slade, A. (1973). Journal of the Geological Society of Australia, Vol. 19, pt. 4 pp 441-452, January 1973.

Stewart, I.C.F. (1975). A Magnitude Scale for Earthquakes in South Australia. Bull. Seis. Soc. Am., Vol. 65, No. 5, pp 1267-1285, October.

Stewart, I.C.F. (1981). Earthquake Risk in South Australia using Averaged Seismic Moments (in press).

Trifunac, M.C. (1976). Notes on the Range of Peak Amplitudes of Recorded Accelerations, Velocities and Displacements with Respect to the Modified Mercalli Intensity Scale. Seis. Soc. Am. Earthquake Notes Vol. 47, No. 1, Jan.-March. 1976 pp 9-24.

Vanmarcke, E.H. and Shih-Sheng P. Lai (1980). Attenuation of Intensity with Epicentral Distance in the Philippines. Bull. Seis. Soc. Am., Vol. 70, No. 4 pp 1287-1291, August.

Weichert, D.H. and Milne, W.G. (1979). Canadian Methodologies of Probabilistic Seismic Risk Estimation. Bull. Seis. Soc. Am., Vol. 69, No. 5, pp 1549-1566, October.

Weichert, D.H. (1980). Estimation of the Earthquake Recurrence Parameters for Unequal Observation Periods for Different Magnitudes. Bull. Seis. Soc. Am., Vol. 70, No. 4, pp 1337-1346 August.

Yegulalp, T.M. and Kuo, J.T. (1974). Statistical Prediction of the Occurrence of Maximum Magnitude Earthquakes, Bull. Seis. Soc. Am., Vol. 64, Pt. 2, pp 393-414.

AS 2121-1979 - SAA Earthquake Code.

U.S. Atomic Energy Commission (1973). Regulatory Guide 1.60.

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APPENDIX A

MODIFIED MERCALLI INTENSITY SCALE

APPENDIX A - THE MODIFIED MERCALLI INTENSITY SCALE

Masonry A, B, C, D. The quality of masonry, brick or otherwise, is specified by the following lettering.

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc; designed to resist lateral forces.

Masonry B. Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

Modified Mercalli Intensity Scale of 1931 (Abridged and Rewritten by C.F. Richter).

I Not felt. Marginal and long-period of large earthquakes.

II Felt by persons at rest, on upper floors, or favorably placed.

III Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames crack.

V Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, and so on, off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken visibly, or heard to rustle.

VII Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets, and architectural ornaments. Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and walls. Cracks in wet ground and on steep slopes.

IX General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frames racked. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.

X Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI Rails bent greatly. Underground pipelines completely out of service.

XII Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

See AS 2121-1979 appendix 1B for more details.

APPENDIX B

RECORDED DATA AND SEISMOMETER NETWORK

SOUTH AUSTRALIAN SEISMOGRAPH STATIONS AS AT JUNE 1982

CODE	LAT.(°S)	LONG.(°E)	ELEV. (M)	FOUNDATION	INSTR.	COMP.	NOMINAL To(S)	Tg(S)	NOMINAL GAIN @ To	NOMINAL MAX. GAIN @ T	REC. METHOD	DATES OF OPERATION	STATUS	PURPOSE	INSTITUTION
ADE	34.9670	138.7136	655	QUARTZITIC	WW	SP Z, N, E	1	.78	25K	37K @ 0.66	Ph	Jul 1958(WWSSN 1962)-	0	WWSSN	BMR/UA
				SANDSTONE		LP Z, N, E	15	100	750						
ADT	34.9670	138.7136	655	SANDSTONE	WII	Z	1	-	39K	83K @ 0.4	I	May 1974 -	0	OL	UA
CLV	33.6911	136.4955	238	MICA SCHISTS	B	Z	1	-	59K	390K @ 0.13	I	Jan 1963 -	0	OL	UA
EDO	32.3216	138.0483	300	QUARTZITE	K	Z	1.5	-	125K	410K @ 0.17	I	Nov 1977 -	0	OL	UA
HKN	30.0120	135.1860	209	CLAY	K	Z	1	-	23K	140K @ 0.17	I	Aug 1975 - Jun 1981	C		UA
HTT	33.4305	138.9217	708	QUARTZITE	B	Z	1	-	69K	560K @ 0.5	I	Jan 1962 -	0	OL	UA
ILN	31.393	136.870	137	CLAY	GT	Z	1	-	undet.	undet.	I	Mar 1970 - Apr 1973	C	OL	UA
MGR	37.7283	140.5710	190	VOLCANIC	K	Z	1	-	17K	250K @ 0.2	I	Apr 1980 -	0	OL	UA
MTA	29.869	135.243	209	CLAY	K	Z	1	-	undet.	undet.	I	Jun 1973 - Aug 1975	C	OL	UA
NBK	32.7010	137.9830	180	SLATE	K	Z	1	-	49K	400K @ 0.17	I	May 1979 -	0	OL	UA
OOD	27.562	135.449	130	ALLUVIUM	WII	Z	1	-	undet.	undet.	I	Aug 1972 - Nov 1972	C	R	UA
PNA	32.0057	138.1647	180	SANDSTONE	WII	Z	1	-	66K	1.1M @ 0.1	I	Sep 1969 -	0	OL	UA
RPA	32.7250	137.4033	95	SANDSTONE	K	Z	2	-	270K	570K @ 0.17	I	Sep 1977 -	0	OL	UA
SNL	33.887	138.639	480	SANDSTONE	WII	Z	1	-	undet.	undet.	I	Jan 1966 - Dec 1971	C	OL	UA
UMB	30.2400	139.1280	610	SILTSTONE	WII	Z	1	-	92K	650K @ 0.13	I	Jun 1967 -	0	OL	UA
WKA	36.4170	140.3210	40	GRANITE	K	Z	1	-	48K	2.4M @ 0.13	I	Mar 1979 -	0	OL	UA
WSA	31.1444	136.8047	180	CLAY	GT	Z	1	-	2.9K	170K @ 0.17	I	Apr 1973 - Oct 1981	C	OL	UA
HWK	29.9578	135.2035	180	CLAY	K	Z	1	-	19K	208K @ 0.2	I	June 1981 -	0	OL	UA
WRG	31.1046	136.7634	168	CLAY	GT	Z	1	-	28K	325K @ 0.13	I	Oct 1981 -	0	OL	UA

KEY

undet. = undetermined

0 = open
C = closed

0 = overseas
L = local
R = regional

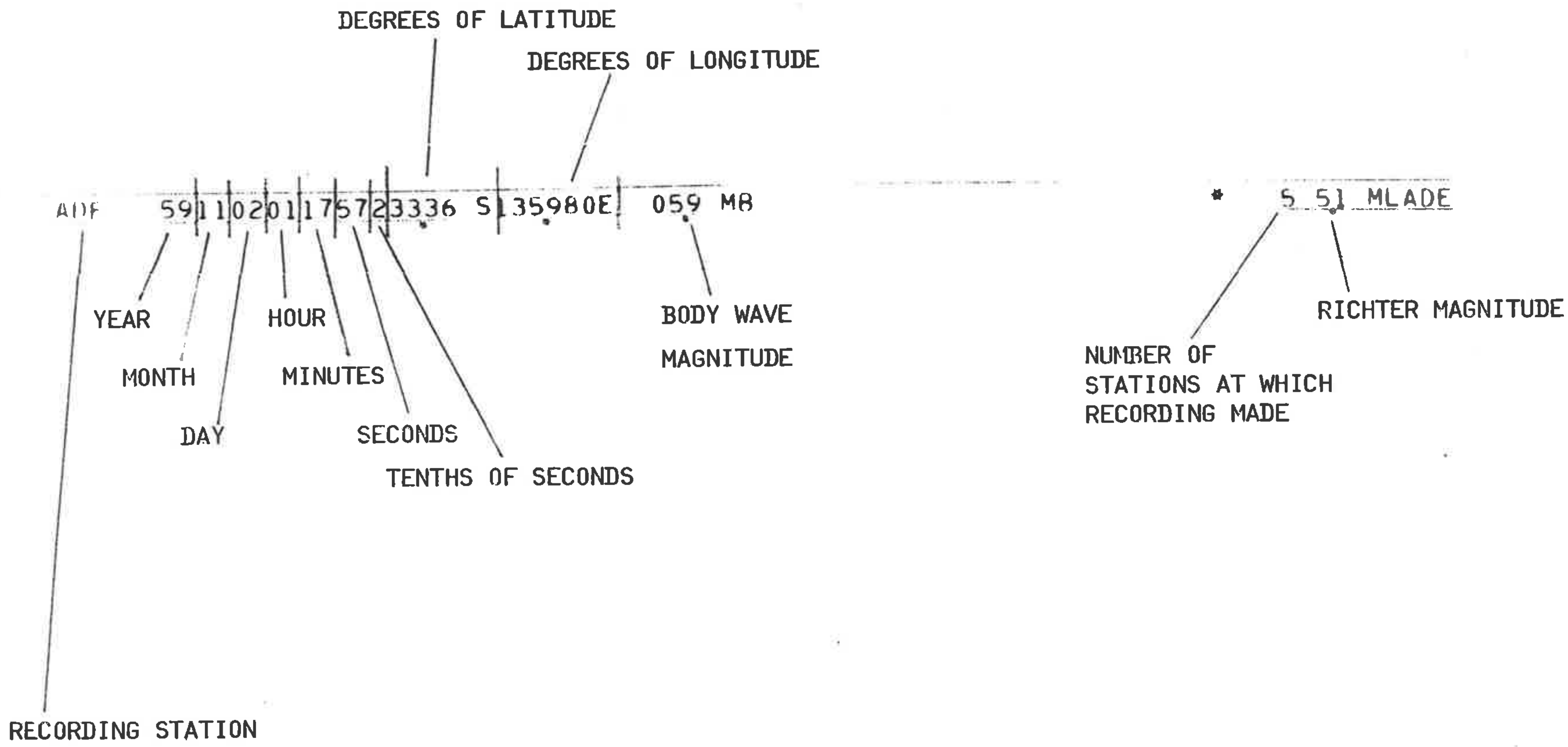
BMR = Bureau of Mineral Resources
UA = University of Adelaide

Ph = photographic
I = pen & ink

WW = Worldwide
WII = Willmore Mk II
B = Benioff
K = Kinemetrics Ranger
GT = Geotech 18300

SOUTH AUSTRALIAN SEISMIC STATIONS AT JUNE 1982

(COURTESY OF UNIVERSITY OF ADELAIDE SEISMOLOGY UNIT)



KEY TO RECORDED DATA

BURK89	2120716	339	S1390	E	33	3		*	0* 00
BURK87	4161331	330	S1390	E	33	4		*	0* 00
BURK87	4162216	340	S1370	E	33	4		*	0* 00
ADE99	502030000037333S139750E				0			*	0 00
ADE97	510052600037333S139750E				066 MB	8	F	*	0 650MLADE
ADE97	510075500037333S139750E				0			*	0 00
BURK86	6010556	355	S1390	E	33	3		*	0* 00
BURK83	7071358	351	S1388	E	33450MB	5		*	0* 00
BURK86	7110701	335	S1385	E	33	3		*	0* 00
BURK90	7242146	331	S1390	E	33	4		*	0* 00
BURK91	8290916	320	S1385	E	33	4		*	0* 00
BURK93	9130206	342	S1390	E	33	3		*	0* 00
BURK91	9180901	345	S1390	E	33	3		*	0* 00
BURK	205070410	327	S1387	E	33	5		*	0 00
BURK	209181705	338	S1388	E		4		*	0*600MLADE
BURK	209191030	353	S1378	E	630MB	7		*	0*590MLRIV
BURK	209200900	353	S1378	E				*	0* 00
BURK	409211345	318	S1385	E		4		*	0* 00
BURK	508211830	342	S1391	E		5		*	0* 00
HOLT	390326035605	318	S1380	E	33600MB		55MS	*	20 560MLRIV
BURKE	390501190729	314	S1380	E	33470MB			*	2 400MLRIV
BURKF	390605122043	315	S1385	E	33470MB			*	2 400MLRIV
BURKE	420214225043	295	S1360	E	33530MB			*	2 450MLRIV
ADE	480806032923037360S139680E				18600MB		F 560RIV	*	0 560MLADE
ADE	540228180952034930S138670E				455 MBCKG8		FD	*	11 540MLADE
ADE	590521112846	314	S1390	E	10540MB			*R	0 440MLADE
ADE	590909041730	327	S1382	E	10530MB			*R	0 430MLADE
ADE	59110201175723336		S135980E		059 MB			*	5 51 MLADE
ADE	600818150448	338	S13615	E	10530MB			*R	0 430MLADE

ADF	600831021450 335	S1364	E	10540MB	*R	0	440MLADE
ADF	601112230308 346	S1355	E	10540MB	*R	0	440MLADE
ADF	610610155800 345	S1350	E	0	*	3	420MLADE
ADF	6201101936250 3635	S13980	E	0510MB	*	3	41 MLADE
ADE	620303220422 330	S1360	E	0520MB	*	3	420MLADE
ADE	620516214137 73549	S13756	E	25550MB	*	6	460MLADE
ADF	620702123013 327	S1390	E	0 ✓	*	3	240MLADE
ADF	620707043004 313	S1386	E	0460MB ✓	*	3	340MLADE
ADE	620718134802 337	S13815	E	0 ✓	*	3	290MLADE
ADE	620906144821 345	S1390	E	0450MB ✓	*	3	330MLADE
ADF	630329215620 311	S1385	E	0510MB	*	3	410MLADE
ADE	630330124027 272	S1409	E	0	*	3	310MLADE
ADE	630331002545 272	S1409	E	0	*	3	310MLADE
ADE	630408090350 324	S1381	E	0	*	3	250MLADE
ADF	630618024056 326	S1386	E	0	*	3	290MLADE
ADE	630729201648034300S135850E			0	*	3	21 MLADE
ADF	630902094403 3235	S13790	E	0	*	3	280MLADE
ADE	630923163257 3495	S1389	E	0	*	3	160MLADE
ADF	6311110935055 3330	S1390	E	0	*	3	120MLADE
ADE	6312030459444 3188	S13842	E	0460MB	*	3	340MLADE
ADE	631208102354 3416	S13913	E	0	*	3	200MLADE
ADE	6312121952327 3222	S13810	E	0	*	3	220MLADE
ADF	6401201258476 3133	S13873	E	21	*	4	310MLADE
ADF	6401212150051 3207	S14023	E	06	*	3	220MLADE
ADF	6401270724210 3488	S13890	E	05	*	3	130MLADE
ADF	6402012054480 3339	S13871	E	09	*	3	120MLADE
ADF	6402021600540 3170	S13920	E	01	*	3	220MLADE
ADF	6402041956022 3552	S13765	E	16	*	3	240MLADE
ADF	6402080537593 3474	S13875	E	15	*	3	240MLADE
ADE	6402081823493 3364	S13885	E	12	*	3	090MLADE

ADE	64030600480053415	S13886	E	16	*	2	260MLADE
ADE	64032620340223270	S13834	E	04	*	3	210MLADE
ADE	64032723513103320	S13810	E	01	*	3	120MLADE
ADE	64033119233703270	S13830	E	01	*	3	160MLADE
ADE	64042210522883517	S13848	E	23	*	3	220MLADE
ADE	64051216491143263	S13865	E	09	*	3	240MLADE
ADE	64052316332483676	S13670	E	00	*	3	310MLADE
ADE	64060106273763498	S13897	E	10	*	3	110MLADE
ADE	64071200390283410	S13466	E	09	*	3	390MLADE
ADE	64071617470193400	S13894	E	20	*	3	240MLADE
ADE	64072514565063489	S13519	E	06	*	3	170MLADE
ADE	64072909365873216	S13914	E	13	*	3	250MLADE
ADE	64080514020003339	S13851	E	12	*	3	240MLADE
ADE	64080608215373280	S13819	E	18	*	3	220MLADE
ADE	64081603113153590	S13720	E	01	*	3	180MLADE
ADE	64081615590702960	S13910	E	01	*	3	240MLADE
ADE	64082716562013360	S13880	E	01	*	3	090MLADE
ADE	64090302490763111	S13942	E	27	*	3	240MLADE
ADE	64091110010303476	S13725	E	00	*	3	200MLADE
ADE	64092822264293252	S13815	E	00	*	3	250MLADE
ADE	64093004365623566	S13822	E	03	*	3	200MLADE
ADE	64101515191173551	S13802	E	10	*	3	170MLADE
ADE	64102123483913650	S13725	E	15	*	3	260MLADE
ADE	64102715511273316	S13842	E	02	*	3	150MLADE
ADE	64120622591563412	S13580	E	00	*	3	180MLADE
ADE	64120720362633314	S13842	E	05	*	3	180MLADE
ADE	64121101005413738	S13970	E	01	*	3	260MLADE
ADE	64121911473913350	S13850	E	01	*	3	170MLADE
ADE	64122604004643416	S13905	E	20	*	3	210MLADE
ADE	64123011244783300	S13747	E	18	*	3	210MLADE

ADE	65010609481602887	S13680	E	01			*	3	210MLADE
ADE	65010609513343335	S13850	E	14			*	3	260MLADE
ADE	65010704235053546	S13807	E	04			*	3	160MLADE
ADE	65011505455653155	S13750	E	02			*	2	160MLADE
ADE	65011702483252797	S13565	E	00330MB			*	10	420MLADE
ADE	65012307112823199	S13853	E	09			*	3	350MLADE
ADE	65012308591803546	S13762	E	02			*	3	180MLADE
ADE	65012401155353380	S13925	E	01			*	3	200MLADE
ADE	65012520225423193	S13849	E	00490MB	5	F	*	12	470MLADE
ADE	65013103325573287	S13813	E	8			*	3	220MLADE
ADE	65022416364823395	S13895	E	23			*	3	280MLADE
ADE	65030113390283035	S13810	E	0			*	6	370MLADE
SYKES	65030215184983056	S13842	E	0530MB	5		*	13	500MLADE
ADE	65030701562913086	S13867	E	10			*	5	310MLADE
ADE	65031412474233195	S13857	E	0510MB	5	F	*	12	480MLADE
ADE	65031413044973193	S13869	E	3			*	3	240MLADE
ADE	65031506232053199	S13856	E	0			*	3	210MLADE
ADE	65031805570053567	S13832	E	9			*	3	160MLADE
ADE	65032304371973560	S13815	E	25			*	3	180MLADE
ADE	65032505205603214	S13851	E	16			*	3	200MLADE
ADE	65032904240943392	S13911	E	0			*	3	160MLADE
ADE	65040610055493064	S13837	E	15			*	3	300MLADE
ADE	65042501142113205	S13839	E	0			*	3	240MLADE
ADE	65050807263403272	S13811	E	0			*	3	200MLADE
ADE	65052817531813166	S13827	E	10			*	3	180MLADE
ADE	65060410451033200	S13848	E	4			*	9	430MLADE
ADE	65060521130183322	S13858	E	17	3	F	*	3	300MLADE
ADE	65061805340353791	S13986	E	0			*	3	280MLADE
ADE	65062013253703243	S13918	E	17			*	3	200MLADE
ADE	65062506405513198	S13856	E	13			*	3	200MLADE

ADE	65070200022983180	S13860	E	30			*	3	220MLADE
ADF	65071509155793289	S13822	E	39			*	3	160MLADE
ADE	65072805261833268	S13798	E	01			*	3	200MLADE
ADE	65082721372433343	S13840	E	01			*	3	160MLADE
ADE	65082800263883223	S13830	E	16470MB	5	F	*	13	500MLADE
ADF	65082800454143238	S13825	E	25	5	F	*	5	440MLADE
ADE	65090119020683255	S13817	E	39			*	3	180MLADE
ADF	65090207155803233	S13812	E	00			*	3	200MLADE
ADF	65090304221363250	S13806	E	00			*	3	220MLADE
ADF	65091711263243246	S13815	E	00			*	3	180MLADE
ADE	65092123243603225	S13920	E	01			*	3	150MLADE
ADF	65092205475743549	S13812	E	00			*	3	130MLADE
ADE	65092319331793482	S13710	E	02			*	3	180MLADE
ADE	65092420423273522	S13914	E	00	3	F	*	3	200MLADE
ADF	65100803104803320	S13800	E	01			*	3	160MLADE
ADF	65100816155813204	S13875	E	00			*	3	180MLADE
ADF	65100918554763331	S13845	E	00			*	3	080MLADE
ADF	65102700410623349	S13855	E	03	4	F	*	2	240MLADE
ADF	65103000241803150	S13810	E	01			*	4	200MLADE
ADF	65110618590283338	S13643	E	00			*	3	170MLADE
ADF	65111503240453541	S13818	E	23			*	3	160MLADE
ADF	65112222150973383	S13433	E	08			*	3	370MLADE
ADE	65120218024913397	S13429	E	09			*	4	180MLADE
ADE	65120803164753246	S13817	E	00			*	3	170MLADE
ADF	65120908163943628	S13623	E	00			*	3	250MLADE
ADE	651209164202632548S137997E			0			*	3	210MLADE
ADF	65121109264503043	S13830	E	01			*	3	260MLADE
ADE	651211194353032912S138097E			3	4	F	*	3	310MLADE
ADE	65121218094673213	S13849	E	07			*	3	210MLADE
ADE	65122507375653550	S13680	E	01			*	4	150MLADE

ADE	66010711383353095	S13930	E	02			*	4	250MLADE
ADE	66012620362953346	S13676	E	07			*	3	220MLADE
ADE	66021510412243624	S13748	E	04			*	3	240MLADE
ADF	66022820351983268	S13774	E	00			*	3	170MLADE
ADF	66030112422213362	S13973	E	00			*	3	240MLADE
ADE	66031819510773335	S13860	E	24			*	3	210MLADE
ADE	66042504462423347	S13633	E	00			*	3	250MLADE
ADF	66062219101373327	S13820	E	24			*	3	150MLADE
ADF	66070108581803255	S13850	E	02			*	3	200MLADE
ADE	66071114483853295	S13820	E	01			*	3	200MLADE
ADF	66071523484093555	S13781	E	12	4	F	*	3	290MLADE
ADE	66072415193753283	S13825	E	26			*	4	200MLADE
ADF	66081921412873331	S13850	E	08			*	3	070MLADE
ADE	66082822325623235	S13871	E	01			*	4	220MLADE
ADE	66090421015013351	S13660	E	20			*	4	200MLADE
ADE	66090918041233310	S13786	E	15			*	3	150MLADE
ADF	66092408064713483	S13861	E	17	4	F	*	4	240MLADE
ADE	66092514473533260	S13796	E	19			*	4	200MLADE
ADF	66101700270473441	S13599	E	24500MB	6	F	*	5	390MLADE
ADF	66102911181363113	S13868	E	17			*	4	220MLADE
ADF	66111110041513315	S13952	E	24			*	4	170MLADE
ADE	66111823372623200	S14010	E	04			*	3	260MLADE
ADE	66111918191543271	S13818	E	22			*	3	260MLADE
ADF	66112320480403435	S13930	E	13410MB	6	F	*	11	430MLADE
ADF	66120412291203246	S13816	E	09			*	4	200MLADE
ADF	66120517073583322	S13918	E	26			*	4	180MLADE
ADF	66120613580213348	S13857	E	26			*	4	110MLADE
ADE	66120702494123334	S13891	E	19470MB	4	F	*	7	350MLADE
ADE	66121813005643402	S13911	E	36	3	F	*	4	090MLADE
ADE	66121813181403406	S13921	E	24	4	F	*	4	200MLADE

ADF	66122022305923403	S13913	E	29			*	4	110MLADE
ADF	66122415131733282	S13831	E	03			*	4	200MLADE
ADF	67010423242813248	S13811	E	12			*	3	240MLADE
ADE	67010601075343170	S13958	E	15			*	3	210MLADE
ADE	67012908150453428	S13929	E	17			*	4	250MLADE
ADF	67013113071343352	S13785	E	02	6	F	*	4	330MLADE
ADF	67021613343483198	S13892	E	29			*	4	200MLADE
ADE	67022516050723318	S13862	E	12			*	4	170MLADE
ADF	67030208131833270	S13811	E	18			*	4	270MLADE
ADE	67032317555523216	S13820	E	01			*	4	160MLADE
ADF	67040204321403291	S13905	E	00			*	4	120MLADE
ADE	67040418032173505	S13909	E	09		F	*	4	290MLADE
ADF	67041119171953400	S13825	E	10			*	4	120MLADE
ADF	67041303012433295	S13923	E	00			*	3	120MLADE
ADE	67041304150133388	S13912	E	22			*	4	160MLADE
ADF	67041400154373434	S13892	E	27			*	4	160MLADE
ADF	67041500351563374	S13886	E	15	4	F	*	6	340MLADE
ADF	67050423345783256	S13799	E	14		F	*	6	390MLADE
ADF	67051103551113244	S13799	E	23			*	4	250MLADE
ADE	67051422424693114	S13874	E	20			*	4	240MLADE
ADF	67051516540103320	S13900	E	05			*	4	130MLADE
ADE	67051623581433244	S13789	E	08			*	4	250MLADE
ADF	67052011202553352	S13866	E	02			*	3	070MLADE
ADE	67052219570853383	S13872	E	20			*	3	180MLADE
ADE	67060621411973498	S13780	E	09			*	4	220MLADE
ADE	67061009171263255	S13789	E	06			*	3	130MLADE
ADE	67061317552093368	S13910	E	10			*	3	290MLADE
ADE	67061707511553259	S13786	E	00			*	3	210MLADE
ADF	67061708314733238	S13906	E	02			*	3	220MLADE
ADE	67070910310123521	S13915	E	00	3	F	*	3	200MLADE

ADE	6707250410294300O	S13810	E	05			*	3	250MLADE
ADE	67072504290213765	S13795	E	10			*	3	250MLADE
ADE	67080802484173267	S13694	E	13			*	3	170MLADE
ADE	67081214323253358	S13860	E	15			*	3	210MLADE
ADE	67081621411613279	S13819	E	00			*	3	290MLADE
ADE	67090610441543375	S13620	E	15			*	4	220MLADE
ADE	67092111143693244	S13804	E	13			*	4	250MLADE
ADE	67100203513513259	S13797	E	18			*	4	240MLADE
ADE	67100219473513252	S13798	E	19			*	4	310MLADE
ADE	67102600514043419	S13784	E	38			*	4	250MLADE
ADE	67110105093333568	S13801	E	19			*	4	220MLADE
ADE	67111713334693335	S13670	E	20			*	4	260MLADE
ADE	67112100020033684	S13789	E	06			*	4	300MLADE
ADE	67120617462273478	S13885	E	07	2	F	*	3	180MLADE
ADE	67122621001233452	S13565	E	00	2	F	*	3	300MLADE
ADE	68012412084783339	S13852	E	04			*	3	210MLADE
ADE	68012815012263206	S13966	E	12			*	4	270MLADE
ADE	68032023534753259	S13833	E	05	2	F	*	4	350MLADE
ADE	68032204582203340	S13829	E	19			*	4	200MLADE
ADE	68041018253433253	S13881	E	00			*	3	300MLADE
ADE	68041508594643248	S13866	E	22			*	4	290MLADE
ADE	68042523405403342	S13881	E	03	2	F	*	3	260MLADE
ADE	68042905081683282	S13900	E	21			*	3	260MLADE
ADE	68042905222413277	S13896	E	23			*	3	270MLADE
ADE	68050509374693170	S13948	E	12			*	3	270MLADE
ADE	68070403470933370	S13840	E	00			*	3	220MLADE
ADE	68072212363353166	S13852	E	00			*	4	250MLADE
ADE	68080113464403124	S13907	E	02			*	4	360MLADE
ADE	68080812323343320	S13823	E	03			*	3	260MLADE
ADE	68080816303283510	S13914	E	00	3	F	*	3	240MLADE

ADE	68082413241223186	S13795	E	06			*	3	310MLADE
ADE	68090117034913532	S13907	E	06	2	F	*	3	210MLADE
ADE	68092313580233435	S13602	E	07		F	*	3	220MLADE
ADE	68111404594743352	S13851	E	38		F	*	3	250MLADE
ADE	68120701585643116	S13891	E	00			*	4	350MLADE
ADE	68121212323583164	S13787	E	00			*	3	290MLADE
ADE	68121803201373499	S13854	E	31			*	3	160MLADE
ADE	68122817255043268	S13836	E	00			*	5	220MLADE
ADE	68123016413823195	S13960	E	01			*	4	260MLADE
ADE	69010822235193381	S13893	E	01	2	F	*	5	290MLADE
ADE	69011918091983305	S13849	E	08			*	4	290MLADE
ADE	69012414440603568	S13539	E	24			*	4	350MLADE
ADE	69012507100313227	S14069	E	00			*	4	310MLADE
ADE	69012616482073227	S14089	E	16			*	3	340MLADE
ADE	69012719170123299	S13824	E	01			*	4	230MLADE
ADE	69012812034803141	S13888	E	01			*	3	210MLADE
ADE	69012915032443180	S13911	E	20			*	5	420MLADE
ADE	69012922444043178	S13930	E	08			*	5	220MLADE
ADE	69013109461603255	S13804	E	02			*	4	340MLADE
ADE	69021709053833348	S13219	E	03			*	4	390MLADE
ADE	69030404192743073	S13896	E	02			*	3	350MLADE
ADE	69031111484003281	S13842	E	06			*	4	190MLADE
ADE	69031307542003210	S13847	E	00			*	4	310MLADE
ADE	69032106053463496	S13889	E	00	2	F	*	3	220MLADE
ADE	69041703365903412	S13573	E	00			*	4	230MLADE
ADE	69041706001463404	S13565	E	00			*	4	260MLADE
ADE	69050309251763332	S13673	E	00			*	4	220MLADE
ADE	69051711593363233	S13809	E	00			*	4	290MLADE
ADE	69053104025503432	S13916	E	00			*	3	220MLADE
ADE	69060117344982962	S13744	E	00			*	5	310MLADE

ADE	69060608001033335	S13846	E	02			*	4	190MLADE
ADE	69060703190533193	S13887	E	18			*	3	220MLADE
ADE	69061103373503329	S13849	E	16			*	4	180MLADE
ADE	69061116445293228	S13873	E	28			*	4	220MLADE
ADE	69061514392573474	S13863	E	19	4	F	*	4	230MLADE
ADE	69070204142953201	S13837	E	06			*	3	170MLADE
ADE	69070321400603090	S13856	E	00			*	4	290MLADE
ADE	69071722582273342	S13836	E	00			*	4	210MLADE
ADE	69072017475283061	S13934	E	38			*	3	220MLADE
ADE	69072111351993499	S13918	E	00	3	F	*	4	260MLADE
ADE	69072914074383436	S13603	E	12			*	3	290MLADE
ADE	69081010100203252	S13849	E	00			*	4	260MLADE
ADE	69081412234443242	S13890	E	28			*	4	220MLADE
ADE	69081814462903563	S13732	E	01			*	3	210MLADE
ADE	69090421020503272	S13820	E	09			*	3	270MLADE
ADE	69090610221033403	S13589	E	00			*	3	260MLADE
ADE	69090707062063319	S13858	E	10			*	3	300MLADE
ADE	69091203001913329	S13701	E	00			*	3	190MLADE
ADE	69091316324953342	S13848	E	00	3	F	*	3	210MLADE
ADE	69091911544443208	S14002	E	01			*	3	230MLADE
ADE	69092214114413276	S13827	E	02			*	3	170MLADE
ADE	69092621511953279	S13819	E	32			*	3	270MLADE
ADE	69093015193413285	S13956	E	00			*	3	180MLADE
ADE	69093020331283184	S13966	E	12			*	3	190MLADE
ADE	69100208111823199	S13977	E	02			*	3	180MLADE
ADE	69100208490943189	S13980	E	00			*	3	220MLADE
ADE	69100214325523191	S13977	E	00			*	3	230MLADE
ADE	69100215041893189	S13975	E	01			*	3	210MLADE
ADE	69100413350873188	S13981	E	00			*	3	210MLADE
ADE	69100907095893187	S13979	E	24			*	3	290MLADE

ADE	69100908451843176	S13961	E	10	*	3	380MLADE
ADE	69100908505693188	S13965	E	09	*	3	230MLADE
ADE	69100908575173177	S13948	E	00	*	3	330MLADE
ADE	69100909181593188	S13966	E	08	*	3	230MLADE
ADE	69100910305743165	S13890	E	00	*	3	220MLADE
ADE	69101015243933215	S13805	E	00	*	3	190MLADE
ADE	69101117490903264	S13985	E	08	*	3	180MLADE
ADE	69101118503733230	S13796	E	00	*	4	220MLADE
ADE	69101210534053176	S13984	E	00	*	3	180MLADE
ADE	69101218060163333	S13853	E	38	*	3	050MLADE
ADE	69101313511343190	S13968	E	08	*	3	210MLADE
ADE	69101318355943187	S13969	E	06	*	3	210MLADE
ADE	69101401350333185	S13973	E	04	*	4	220MLADE
ADE	69101412183483187	S13951	E	01	*	3	230MLADE
ADE	69101623522723192	S13971	E	06	*	3	230MLADE
ADE	69101901472463364	S13658	E	00	*	4	300MLADE
ADE	69101902093043361	S13658	E	00	*	4	170MLADE
ADE	69103121560513191	S13977	E	20	*	3	170MLADE
ADE	69110306554403316	S13825	E	01	*	3	130MLADE
ADE	69110317491763352	S13845	E	11	*	3	170MLADE
ADE	69110416343373191	S13974	E	03	*	4	260MLADE
ADE	69110420234363187	S13975	E	00	*	4	230MLADE
ADE	69110717334323450	S13920	E	00	*	5	250MLADE
ADE	69110904232603407	S13582	E	05	*	5	240MLADE
ADE	69111500143043712	S13985	E	09	*	5	310MLADE
ADE	69112312243193359	S13646	E	14	*	4	220MLADE
ADE	69112312413863359	S13652	E	13	*	3	110MLADE
ADE	69112510264483174	S13904	E	00	*	3	220MLADE
ADE	69112803371473172	S13935	E	00	*	4	260MLADE
ADE	69112804344683351	S13788	E	00	*	3	140MLADE

ADF	69113007410793221	S13923	E	12		*	3	190MLADE
ADF	69113009024113276	S13935	E	02		*	3	260MLADE
ADF	69113023402903172	S13909	E	00		*	3	230MLADE
ADF	69120601455543220	S13850	E	15		*	3	140MLADE
ADF	70011704573443366	S13874	E	06		*	3	250MLADE
ADF	70020406420033334	S13665	E	06		*	4	230MLADE
ADF	70020514175413400	S13814	E	08		*	5	150MLADE
ADF	70021208072143166	S13821	E	05		*	3	190MLADE
ADF	70021301425133178	S13942	E	00		*	4	230MLADE
ADF	70021921484563266	S13820	E	01		*	4	190MLADE
ADF	70022605283253540	S13814	E	07		*	4	180MLADE
ADF	70030108195023143	S13898	E	14		*	4	220MLADE
ADF	70030519310063389	S13809	E	00		*	3	140MLADE
ADF	70030914104383268	S13873	E	38		*	3	130MLADE
ADF	70031604584643188	S13827	E	00		*	3	250MLADE
ADE	70032604294313342	S13830	E	09		*	5	270MLADE
ADE	70040618012903168	S13884	E	17		*	3	140MLADE
ADF	70040820352833282	S13804	E	07		*	4	190MLADE
ADE	70041216095373148	S13909	E	09		*	3	140MLADE
ADF	70041515520473186	S13866	E	00		*	3	110MLADE
ADE	70042116434583379	S13909	E	07		*	5	260MLADE
ADF	70042400025193372	S13618	E	00		*	4	150MLADE
ADE	70042617381583452	S13954	E	04		*	5	190MLADE
ADE	70042811443593109	S13860	E	08	F	*	3	300MLADE
ADF	70042911513963252	S13821	E	10		*	5	180MLADE
ADF	70043005052803306	S13686	E	00	F	*	3*	170MLADE
ADE	70050619042043322	S13642	E	08		*	5	220MLADE
ADF	70051410034753318	S13895	E	17		*	6	250MLADE
ADF	70051511121623271	S13822	E	00		*	4	140MLADE
ADE	70051622073213269	S13846	E	11		*	3	190MLADE

ADE	70052109581903241	S13850	E	02			*	5	140MLADE
ADE	70052310490163178	S13942	E	01			*	7	250MLADE
ADE	70052405200083130	S13873	E	38			*	3	070MLADE
ADE	70052721051443130	S13883	E	38			*	3	060MLADE
ADE	70060604404413212	S13851	E	02			*	6	290MLADE
ADE	70061311033633301	S13812	E	02			*	4	130MLADE
ADE	70061321030643411	S13889	E	03			*	5	220MLADE
ADE	70061500051983275	S13827	E	05			*	5	220MLADE
ADE	70062818243823303	S13816	E	00			*	3	190MLADE
ADE	70070407260733207	S13857	E	00			*	5	190MLADE
ADE	70071003342043176	S13935	E	01			*	5	270MLADE
ADE	70071103201663368	S13880	E	04			*	6	260MLADE
ADE	70072119315353090	S13862	E	06			*	4	260MLADE
ADE	70072617485143101	S13857	E	05			*	5	180MLADE
ADE	70072705134913173	S13951	E	10			*	6	370MLADE
ADE	70072912125013169	S13828	E	00			*	6	190MLADE
ADE	70073118203733097	S13893	E	07			*	6	310MLADE
ADE	70080602283493517	S13890	E	00			*	3	170MLADE
ADE	70080607313833203	S13848	E	00			*	3	140MLADE
ADE	70081100142373187	S13960	E	03			*	3	190MLADE
ADE	70082902400823373	S13884	E	05			*	3	180MLADE
ADE	70083115370303345	S13862	E	01			*	3	190MLADE
ADE	70090602004253322	S13946	E	07			*	6	210MLADE
ADE	70091320465283155	S13905	E	06			*	6	230MLADE
ADE	70091617402473321	S13858	E	00	5	F	*	12	370MLADE
ADE	70091703455473323	S13863	E	04		F	*	3	150MLADE
ADE	70092117403663342	S13642	E	02			*	3	210MLADE
ADE	70100514151743329	S13813	E	03			*	6	290MLADE
ADE	70100922311003269	S13837	E	00			*	5	260MLADE
ADE	70101312493873071	S13858	E	04			*	5	260MLADE

ADF	70110807464403176	S13860	E	00			*	4	190MLADE
ADF	70111010470263341	S13920	E	07			*	5	260MLADE
ADF	70111201574113168	S13869	E	00			*	6	270MLADE
ADF	70111304100013500	S13813	E	12			*	4	190MLADE
ADF	70111318405713182	S13963	E	04			*	5	210MLADE
ADF	70111911122993115	S13861	E	00			*	4	260MLADE
ADF	70112112322503248	S13879	E	00			*	5	220MLADE
ADF	70120909360213373	S13874	E	00			*	5	270MLADE
ADF	70121914004023184	S13940	E	02			*	3	180MLADE
ADF	70122015122553184	S13947	E	03			*	4	180MLADE
ADF	71010417314213423	S13914	E	08	2	F	*	5	260MLADE
ADF	71010623543033346	S13856	E	12	6	F	*	11	460MLADE
ADF	71010716412013348	S13865	E	05			*	5	170MLADE
ADF	71010815400583322	S13859	E	00	3	F	*	6	190MLADE
ADF	71010902334813349	S13866	E	00			*	6	210MLADE
ADF	71011720475203333	S13846	E	01			*	4	110MLADE
ADF	71012317070943121	S13879	E	02			*	3	130MLADE
ADF	71012513092012850	S13702	E	01			*	4	270MLADE
ADF	71012709403813462	S13919	E	07			*	6	230MLADE
ADF	71020210084703268	S13776	E	03			*	5	190MLADE
ADF	71020910093003411	S13631	E	05			*	4	190MLADE
ADF	71022222211813521	S13905	E	02			*	4	210MLADE
ADF	71022803552573260	S13805	E	03			*	3	180MLADE
ADF	71022807194373321	S13870	E	00			*	3	130MLADE
ADF	71030801063413347	S13815	E	04			*	5	260MLADE
ADF	71031012155713213	S13807	E	05	2	F	*	3	260MLADE
ADF	71031108460563542	S13610	E	00			*	6	250MLADE
ADF	71031914234543314	S13798	E	09			*	5	130MLADE
ADF	71032507415852936	S13773	E	05			*	5	150MLADE
ADF	71032810111562977	S13785	E	02			*	3	210MLADE

ADE	71033008185323137	S13716	E	00			*	4	150MLADE
ADE	71040407264493335	S13850	E	03			*	3	150MLADE
ADE	71040508094513182	S13962	E	04			*	5	210MLADE
ADE	71040905513493154	S13881	E	02			*	3	100MLADE
ADE	71040910312253323	S13840	E	05			*	4	170MLADE
ADE	71041414120403521	S13867	E	04	2	F	*	6	230MLADE
ADE	71050300561233137	S13934	E	06			*	3	150MLADE
ADE	71051419003222826	S13844	E	10			*	5	250MLADE
ADE	71051420591663318	S13867	E	06			*	5	150MLADE
ADE	71051613474653328	S13860	E	00			*	5	140MLADE
ADE	71052123541103330	S13808	E	06			*	7	310MLADE
ADE	71052815301263027	S13778	E	14			*	3	190MLADE
ADE	71053002175953636	S13885	E	08			*	6	210MLADE
ADE	71061202463443395	S13703	E	04			*	3	130MLADE
ADE	71061508113643330	S13815	E	07			*	4	180MLADE
ADE	71061909431992821	S13581	E	02			*	3	270MLADE
ADE	71062210111113399	S13546	E	08			*	3	210MLADE
ADE	71062803202383240	S13830	E	04			*	3	210MLADE
ADE	71070115412263285	S13780	E	09			*	7	230MLADE
ADE	71070308594713535	S13838	E	10		F	*	6	300MLADE
ADE	71070322201872842	S13593	E	04			*	4	270MLADE
ADE	71070323551722814	S13706	E	06			*	3	250MLADE
ADE	71070915395013351	S13659	E	12		F	*	7	330MLADE
ADE	71071109562052868	S13607	E	05			*	4	230MLADE
ADE	71071211561112879	S13615	E	06			*	7	310MLADE
ADE	71071717214753331	S13824	E	10			*	3	130MLADE
ADE	71071723473403340	S13847	E	01			*	3	130MLADE
ADE	71072114251983153	S13842	E	05			*	2	100MLADE
ADE	71072117003153155	S13842	E	05			*	2	130MLADE
ADE	71072317053173182	S13876	E	02			*	4	190MLADE

ADE	71072607503303137	S13876	E	19		F	*	7	500MLADE
ADE	71072620461923464	S13603	E	11	2	F	*	5	260MLADE
ADE	71080220501012891	S13586	E	10			*	3	220MLADE
ADE	71080310561683194	S13837	E	08			*	4	150MLADE
ADE	71080509411943463	S13943	E	08			*	4	180MLADE
ADE	71082200153653195	S13889	E	03			*	6	220MLADE
ADE	71090810282672850	S13565	E	10			*	4	230MLADE
ADE	71091012074493434	S13894	E	08			*	7	210MLADE
ADE	71091023461843354	S13673	E	06			*	7	270MLADE
ADE	71091118233683200	S13880	E	05			*	4	140MLADE
ADE	71091603340993340	S13844	E	00			*	4	140MLADE
ADE	71092200501893242	S13873	E	08			*	3	210MLADE
ADE	71092315114323420	S13565	E	06			*	3	180MLADE
ADE	71092318384663430	S13581	E	00			*	3	170MLADE
ADE	71100307333083167	S13956	E	06			*	6	250MLADE
ADE	71100405192363173	S13962	E	07			*	6	190MLADE
ADE	71100407554363314	S13860	E	10			*	4	130MLADE
ADE	71100507011813179	S13962	E	09			*	7	260MLADE
ADE	71100507014863173	S13983	E	02			*	7	390MLADE
ADE	71100507230023189	S13966	E	15			*	3	140MLADE
ADE	71100507242923181	S13960	E	08			*	5	250MLADE
ADE	71100508315383184	S13968	E	00			*	4	190MLADE
ADE	71100508431263185	S13973	E	02			*	2	100MLADE
ADE	71100513063473186	S13966	E	02			*	4	190MLADE
ADE	71100515512523298	S13841	E	04			*	3	130MLADE
ADE	71100521285723190	S13961	E	06			*	4	170MLADE
ADE	71100603160693013	S13847	E	12			*	2	170MLADE
ADE	71100613240543189	S13968	E	12			*	7	330MLADE
ADE	71100620150733169	S13960	E	04			*	6	190MLADE
ADE	71100701152963194	S13936	E	00			*	4	130MLADE

ADE	71100815423763250	S13898	E	06			*	7	350MLADE
ADE	71100815470373255	S13948	E	10			*	5	220MLADE
ADE	71101015331153195	S13980	E	07			*	4	140MLADE
ADE	71101018160533248	S13885	E	05			*	6	210MLADE
ADE	71101021435043178	S13952	E	00			*	4	140MLADE
ADE	71101619451193349	S13861	E	04			*	4	190MLADE
ADE	71101813211823131	S13836	E	11			*	5	390MLADE
ADE	71102117284483172	S13950	E	02			*	5	290MLADE
ADE	71102504355203176	S13870	E	01			*	6	270MLADE
ADE	71102511481713191	S13974	E	03			*	5	230MLADE
ADE	71110121141863184	S13946	E	08			*	4	170MLADE
ADE	71110213264263183	S13960	E	06			*	5	150MLADE
ADE	71110516113893031	S13978	E	07	2	F	*	6	380MLADE
ADE	71110605124003314	S13838	E	02			*	4	190MLADE
ADE	71111920380633251	S13797	E	07			*	5	270MLADE
ADE	71112321555863164	S13933	E	05			*	5	190MLADE
ADE	71112618560413312	S13827	E	00			*	3	190MLADE
ADE	71112918311243367	S13860	E	00			*	4	170MLADE
ADE	71120214502153131	S13865	E	03			*	5	210MLADE
ADE	71122901463613161	S13882	E	05			*	6	270MLADE
ADE	72010102060173726	S13968	E	8			*	4	350MLADE
ADE	72010105033173714	S14012	E	3			*	4	270MLADE
ADE	72011111095243171	S13928	E	4			*	4	220MLADE
ADE	72011701085723186	S13977	E	5			*	3	190MLADE
ADE	72012713392973204	S13812	E	0	2	F	*	4	200MLADE
ADE	72022014250203420	S13601	E	5			*	4	250MLADE
ADE	72022409484243232	S13920	E	8			*	4	180MLADE
ADE	72030112190813263	S13836	E	4			*	4	170MLADE
ADE	72030320571253209	S13858	E	3			*	3	160MLADE
ADE	72030719413543355	S13686	E	7			*	4	210MLADE

ADE	72031609574903128	S13866	E	7			*	3	230MLADE
ADE	72032000284763159	S13863	E	6			*	3	130MLADE
ADE	72032421004003154	S13864	E	6			*	3	220MLADE
ADE	72032611580892986	S13954	E	9	2	F	*	3	190MLADE
ADE	72033010463843141	S13889	E	6			*	6	290MLADE
ADE	72033014353953311	S13808	E	5			*	4	190MLADE
ADE	72040217165113111	S13860	E	9			*	5	250MLADE
ADE	72040708560243201	S13881	E	4			*	6	250MLADE
ADE	72040719084873153	S13819	E	8			*	3	130MLADE
ADE	72040903581463204	S13979	E	5			*	3	240MLADE
ADE	72041821224143138	S13866	E	8			*	5	210MLADE
ADE	72041822203973158	S13862	E	12	4	F	*	6	550MLADE
ADE	72041904380363162	S13863	E	7			*	5	250MLADE
ADE	72041912442613343	S13848	E	6			*	5	230MLADE
ADE	72042216341452883	S13899	E	0			*	3	230MLADE
ADE	72042518125803301	S13926	E	6			*	4	170MLADE
ADE	72042711502863126	S13889	E	12	2	F	*	5	360MLADE
ADE	72042713112213141	S13876	E	11			*	4	300MLADE
ADE	72042815442323121	S13857	E	38			*	3	090MLADE
ADE	72050517073722898	S13773	E	09			*	4	200MLADE
ADE	72050612114503182	S13955	E	08			*	5	280MLADE
ADE	72050707002043205	S13898	E	10			*	3	170MLADE
ADE	72053023163453526	S13566	E	12			*	6	310MLADE
ADE	72060702490643182	S13949	E	06			*	6	270MLADE
ADE	72060712173433015	S13848	E	07			*	3	130MLADE
ADE	72061122370573316	S13927	E	08			*	4	240MLADE
ADE	72062800400013300	S13856	E	04			*	4	190MLADE
ADE	72070912110243328	S13854	E	00			*	4	200MLADE
ADE	72071405552643189	S13969	E	03			*	4	200MLADE
ADE	72071414232313197	S13984	E	02			*	4	200MLADE

ADE	72071819431493086	S13854	E	07			*	3	200MLADE
ADE	72071819505723073	S13840	E	06			*	3	130MLADE
ADE	72071820022813090	S13855	E	06			*	3	200MLADE
ADE	72072106192173353	S13538	E	01			*	4	240MLADE
ADE	72080618390523083	S13848	E	05			*	3	180MLADE
ADE	72081409053543358	S13639	E	08	2	F	*	5	290MLADE
ADE	72081620432123160	S13870	E	05			*	4	190MLADE
ADE	72082617454102950	S13753	E	10			*	3	240MLADE
ADE	72090610511313372	S13650	E	09			*	5	270MLADE
ADE	72090612085503389	S13649	E	01			*	3	210MLADE
ADE	72090708304363285	S13819	E	00			*	3	200MLADE
ADE	72090911553523386	S13913	E	21			*	4	190MLADE
ADE	72091913175433340	S13855	E	04			*	5	190MLADE
ADE	72093016204623571	S13717	E	14			*	4	240MLADE
ADE	72101122373303320	S13819	E	06			*	5	280MLADE
ADE	72101712400653500	S13851	E	06	2	F	*	6	320MLADE
ADE	72102300475613174	S13933	E	05			*	5	220MLADE
ADE	72102719015223121	S13881	E	08			*	4	210MLADE
ADE	72102916093633261	S13834	E	01			*	5	210MLADE
ADE	72110710323133241	S13874	E	07			*	5	290MLADE
ADE	72110912235703233	S13828	E	27			*	5	280MLADE
ADE	72111014004003228	S13905	E	08			*	5	280MLADE
ADE	72111014504843233	S13899	E	01			*	4	190MLADE
ADE	72111814512183155	S13869	E	08			*	3	200MLADE
ADE	72120510105053249	S13822	E	08			*	4	230MLADE
ADE	72122210244013351	S13853	E	00			*	3	190MLADE
ADE	72122218504393674	S13826	E	07			*	6	240MLADE
ADE	72122220294573361	S13631	E	00			*	5	210MLADE
ADE	72122513475563240	S13826	E	23			*	4	260MLADE
ADE	73011412242063229	S13909	E	8			*	4	260MLADE

ADE	73011515440443234	S13909	E	0	*	3	220MLADE
ADE	73011700283603121	S13871	E	4	*	3	250MLADE
ADE	73012201100003273	S13828	E	00	*	2	190MLADE
ADE	73012812035433260	S13512	E	21	*	4	350MLADE
ADE	73012812154973243	S13541	E	4	*	3	220MLADE
ADE	73012910014693087	S13879	E	12	*	5	270MLADE
ADE	73013020470763355	S13584	E	05	*	3	230MLADE
ADE	73013021120043452	S13571	E	5	*	3	200MLADE
ADE	73013120023133438	S13578	E	4	*	5	230MLADE
ADE	73020100233703400	S13576	E	5	*	5	260MLADE
ADE	73020121082003354	S13876	E	16	*	3	230MLADE
ADE	73020413034343346	S13863	E	4	*	4	300MLADE
ADE	73020420445923252	S13844	E	9	*	3	190MLADE
ADE	73020712263813346	S13864	E	10	*	4	310MLADE
ADE	73020818092733393	S13569	E	7	*	3	230MLADE
ADE	73021210225213347	S13870	E	7	*	5	230MLADE
ADE	73021816585223312	S13845	E	6	*	3	230MLADE
ADE	73022022361963294	S13896	E	7	*	4	260MLADE
ADE	73022022394543196	S13901	E	3	*	4	150MLADE
ADE	73022100400483375	S13575	E	1	*	4	220MLADE
ADE	73022100485083417	S13595	E	0	*	4	270MLADE
ADE	73022117091413423	S13574	E	25	*	3	190MLADE
ADE	73022309205943409	S13558	E	6	*	4	300MLADE
ADE	73022321270353318	S13896	E	10	*	3	130MLADE
ADE	73030519175053228	S13798	E	8	*	4	330MLADE
ADE	73032018364103319	S13705	E	4	*	3	00MLADE
ADE	73040718532023562	S13758	E	6	*	3	270MLADE
ADE	73041314114073164	S13843	E	14	*	4	260MLADE
ADE	73041317213203165	S13847	E	10	*	4	250MLADE
ADE	73041323292393139	S13838	E	11	*	4	260MLADE

ADE	7304141102074 3312	S13815	E	12	*	3	150MLADE
ADE	7304291852569 3204	S13887	E	00	*	3	210MLADE
ADE	7305241234399 3565	S13787	E	3	*	4	230MLADE
ADE	7306221752555 3322	S13866	E	11	*	6	220MLADE
ADE	7306231513243 3318	S13872	E	14	*	6	270MLADE
ADE	7306231651072 3128	S13869	E	8	*	4	210MLADE
ADE	7306281844206 3342	S13860	E	00	*	5	190MLADE
ADE	7306301158224 2981	S13802	E	2	*	4	310MLADE
ADE	7306301440600 3145	S13890	E	4	*	3	150MLADE
ADE	7307131426557 3394	S13632	E	00	*	4	250MLADE
ADE	7307131920599 3394	S13632	E	00	*	4	250MLADE
ADE	7307171554024 3293	S13964	E	16	*	3	150MLADE
ADE	7307211546168 3338	S13845	E	14	*	5	220MLADE
ADE	7307300956183 3047	S13843	E	28	*	6	250MLADE
ADE	7307300959410 3039	S13842	E	19	*	6	230MLADE
ADE	7308040739251 3531	S13821	E	8	*	5	350MLADE
ADE	7308082009255 3259	S14059	E	1	*	4	230MLADE
ADE	7308090328281 3345	S13847	E	00	*	4	260MLADE
ADE	7308092012488 3222	S13826	E	3	*	4	140MLADE
ADE	7308111950570 3350	S13868	E	00	*	4	190MLADE
ADE	7308121306007 3347	S13872	E	00	*	5	230MLADE
ADE	7308121317384 3342	S13875	E	13	*	4	180MLADE
ADE	7308121430209 3341	S13875	E	11	*	3	180MLADE
ADE	7308301456567 3155	S13953	E	79	*	3	190MLADE
ADE	7309041954225 3153	S13846	E	00	*	3	180MLADE
ADE	7309130257298 3291	S13945	E	3	*	6	310MLADE
ADE	7309131929160 3040	S13834	E	4	*	6	250MLADE
ADE	7309151951062 2956	S13772	E	4	*	5	260MLADE
ADE	7310040610096 2844	S13609	E	14	*	5	290MLADE
ADE	7310122058141 3347	S13840	E	7	*	3	170MLADE

ADE	73101612180493334	S13839	E	9	*	5	260MLADE
ADE	73101801453063392	S13949	E	14	*	4	270MLADE
ADE	73103107521763275	S13904	E	5	*	4	190MLADE
ADE	73110805515593187	S13836	E	9	*	4	230MLADE
ADE	7311161914319337B	S13659	E	12	*	7	230MLADE
ADE	73112011535413102	S13842	E	17	*	5	210MLADE
ADE	73112011593683094	S13837	E	11	*	5	190MLADE
ADE	73112012060743100	S13840	E	9	*	5	210MLADE
ADE	73112012153053102	S13843	E	12	*	5	210MLADE
ADE	73112013065463101	S13843	E	8	*	5	220MLADE
ADE	73112013204523110	S13846	E	00	*	3	170MLADE
ADF	73112013242013091	S13835	E	10	*	5	190MLADE
ADF	73112014251873094	S13837	E	12	*	5	190MLADE
ADE	73112015533333102	S13842	E	11	*	5	250MLADE
ADF	73112015582873103	S13839	E	11	*	5	210MLADE
ADE	73112100232353107	S13846	E	19	*	3	00MLADE
ADE	73112100280603102	S13841	E	14	*	3	00MLADE
ADE	73112116355053106	S13843	E	14	*	3	00MLADE
ADE	73112117491443108	S13845	E	10	*	4	170MLADE
ADE	73112119042233100	S13840	E	18	*	6	220MLADE
ADE	73112119081013099	S13836	E	1	*	5	210MLADE
ADE	73112120131573100	S13843	E	4	*	4	190MLADE
ADE	73112121331693101	S13840	E	15	*	4	190MLADE
ADE	73112121404463108	S13840	E	8	*	4	230MLADE
ADE	73112122084213104	S13844	E	10	*	4	170MLADE
ADE	73112122103383101	S13846	E	22	*	7	270MLADE
ADE	73112122181133106	S13840	E	10	*	4	180MLADE
ADE	73112122313533099	S13841	E	17	*	3	0 MLADE
ADE	73112122320883107	S13846	E	9	*	6	190MLADE
ADE	73112123161573099	S13845	E	26	*	5	210MLADE

ADE	73112123181203101	S13839	E	10		*	3	00MLADE
ADE	73112200001543104	S13842	E	9		*	6	210MLADE
ADE	73112205065853102	S13843	E	14		*	5	210MLADE
ADE	73112319161543322	S13861	E	1		*	5	230MLADE
ADE	73120622521363341	S13866	E	7		*	4	250MLADE
ADE	73121608512633211	S13924	E	7		*	6	260MLADE
ADE	73123013081943180	S13874	E	7		*	3	00MLADE
ADE	74011022080443324	S13864	E	13		*	4	22 ML
ADE	74011404404733283	S13826	E	20		*	4	27 ML
ADE	74011919540523218	S13880	E	4		*	6	37 ML
ADE	74012215024403331	S13820	E	6		*	5	23 ML
ADE	74013111175773160	S13849	E	4		*	4	00
ADE	74020409065823170	S13873	E	8		*	5	23 ML
ADE	74020707460713134	S13898	E	2		*	5	21 ML
ADE	74021222422003200	S13815	E	10		*	3	22 ML
ADE	74021317041363178	S13947	E	3		*	4	00
ADE	74022700571772845	S13682	E	6		*	6	45 ML
BMR	74022701571942877	S13646	E	10		*	8	450MLADE
ADE	74031514583653268	S13831	E	9		*	6	23 ML
ADE	74032119154243341	S13929	E	0		*	4	23 ML
ADE	74032413593953446	S13885	E	13	2	*	6	29 ML
ADE	74032708032853272	S13708	E	0		*	7	31 ML
ADE	74032815400053151	S13867	E	19		*	6	17 ML
ADE	74032914300513175	S13892	E	9		*	4	15 ML
ADE	74040110474062889	S13648	E	9		*	4	27 ML
ADE	74040918175443190	S13967	E	0		*	4	14 ML
ADE	74041508005793249	S13802	E	1		*	6	25 ML
ADE	74041722255663188	S13858	E	1		*	5	19 ML
ADE	74042021012593229	S13830	E	6		*	5	18 ML
ADE	74042711563983110	S13844	E	16		*	5	17 ML

ADE	74043002324943228	S13790	E	7	2	*	7	34	ML
ADE	74050206170263182	S13850	E	1		*	5	14	ML
ADE	74050315065313240	S13834	E	8		*	4	14	ML
ADE	74050612164093246	S13800	E	6		*	6	26	ML
ADE	74051013582853316	S13668	E	8		*	6	23	ML
ADE	74051021171202985	S13671	E	2		*	5	21	ML
ADE	74051115332113304	S13705	E	21		*	5	17	ML
ADE	74051808044533287	S13823	E	13		*	5	18	ML
ADE	74051821234223244	S13816	E	12		*	4	17	ML
ADE	74052304461563184	S13943	E	1		*	4	22	ML
ADE	74052409593563228	S13805	E	7		*	3	14	ML
ADE	74052519004723232	S13817	E	17		*	5	15	ML
ADE	74061316020843147	S13933	E	3		*	6	23	ML
ADE	74061411470022979	S13778	E	0		*	4	25	ML
ADE	74062216452623176	S13941	E	8		*	7	25	ML
ADE	74062720132283259	S13832	E	30		*	3	00	
ADE	74063005493313219	S13858	E	15		*	3	00	
ADE	74063021310283275	S13831	E	13		*	6	19	ML
ADE	74070917413353259	S13862	E	22		*	7	25	ML
ADE	74071004424773198	S13847	E	16		*	4	15	ML
ADE	74071618165443263	S13873	E	21		*	3	18	ML
ADE	74072310450133116	S13880	E	11		*	4	18	ML
ADE	74073019004602781	S13594	E	12		*	4	21	ML
ADE	74073114143723291	S13919	E	11		*	4	18	ML
ADE	74080808091243285	S13837	E	0		*	4	25	ML
ADE	74081418521283169	S13915	E	4		*	4	22	ML
ADE	74081600051523318	S13857	E	6		*	3	23	ML
ADE	74081606581863290	S13700	E	20		*	3	25	ML
ADE	74081706500963316	S13865	E	12		*	4	26	ML
ADE	74082317061863237	S13908	E	1		*	3	17	ML

ADE	740830192241 83098	S13862	E	7		*	4	21	ML
ADE	74100710565493248	S13835	E	13		*	5	18	ML
ADE	74101906373523294	S13703	E	6		*	6	18	ML
ADE	74102900571053128	S13825	E	21		*	6	22	ML
ADE	74110909583323244	S13807	E	9		*	8	38	ML
ADE	74111520121663345	S13871	E	11		*	6	21	ML
ADE	74111709383583297	S13762	E	32		*	3	00	
ADE	74111804115893374	S13672	E	12		*	7	38	ML
ADE	74111923471293144	S13821	E	8		*	3	00	
ADE	74121017575663279	S13963	E	10		*	3	00	
ADE	74121318533663503	S13706	E	18		*	8	39	ML
ADE	74121709480752960	S13745	E	9		*	4	0	
ADE	75010302181433124	S13872	E	6		*	7	37	MLADE
ADE	75012302095513285	S13800	E	7	F	*	7	27	MLADE
ADF	75020604012313035	S13838	E	9		*	4	00	MLADE
ADE	75022514244003335	S13843	E	16	F	*	4	25	MLADE
ADF	75022514543003334	S13841	E	10	F	*	4	28	MLADE
ADF	75030310103373225	S13962	E	10		*	3	21	MLADE
ADE	75030317145973305	S13795	E	00		*	3	24	MLADE
ADF	75031303305673307	S13757	E	10		*	3	28	MLADE
ADE	75031516205253305	S13969	E	00	F	*	4	33	MLADE
ADF	75031622535183213	S13894	E	8		*	5	29	MLADE
ADF	75031823491813186	S13855	E	12		*	4	21	MLADE
ADE	75040611015253569	S13799	E	21		*	8	38	MLADE
ADE	75041117224913149	S13848	E	15		*	4	00	MLADE
ADE	75042816182933097	S13858	E	12		*	4	28	MLADE
ADF	75042922072623217	S13893	E	00		*	6	36	MLADE
BMR	75050817423003670	S14080	E	10		*	5	27	MLTGO
ADE	75051109434273311	S13903	E	5		*	4	29	MLADE
ADE	75051113251263286	S13896	E	00		*	3	24	MLADE

ADE	75052314070202953	S13770	E	14		*	4	34	MLADE
ADE	75053104191053123	S13903	E	14		*	4	27	MLADE
ADE	75060706430183274	S13681	E	20		*	3	15	MLADE
ADE	75061513060563741	S13926	E	8		*	7	36	MLADE
ADE	75062300250313292	S13879	E	1		*	6	23	MLADE
ADE	75062300274113279	S13899	E	15		*	6	29	MLADE
ADE	75062302334883756	S13913	E	24		*	6	32	MLADE
ADE	75070214295073237	S13770	E	5		*	7	27	MLADE
ADE	75071418022293525	S13858	E	24	F	*	7	37	MLADE
ADE	75072007214503281	S13811	E	28		*	3	25	MLADE
ADE	75081123231243369	S13952	E	7		*	5	25	MLADE
ADE	75081618171963203	S13849	E	15		*	4	19	MLADE
ADE	75081814472693194	S13855	E	15		*	4	23	MLADE
ADE	75082108412483290	S13822	E	2		*	4	25	MLADE
ADE	75082909234583065	S13940	E	38		*	4	27	MLADE
ADE	75082916491963166	S13850	E	16		*	4	28	MLADE
ADE	75090412262063124	S13833	E	7		*	5	27	MLADE
ADE	75090605211223141	S13860	E	8		*	4	25	MLADE
ADE	75090610115573305	S13871	E	10		*	6	24	MLADE
ADE	75091112385823329	S13836	E	10		*	7	30	MLADE
ADE	75091908274743182	S13932	E	7		*	5	28	MLADE
ADE	75092422320163113	S13888	E	11		*	6	29	MLADE
ADE	75093004485093070	S13846	E	5		*	4	28	MLADE
ADE	75102001310153351	S13629	E	14		*	5	32	MLADE
ADE	75102420173663405	S13880	E	10		*	3	17	MLADE
ADE	75102620113543190	S13871	E	13		*	3	30	MLADE
ADE	75102807353343188	S13846	E	7		*	3	21	MLADE
ADE	75110505310563317	S13723	E	13		*	3	16	MLADE
ADE	75111105151483339	S13849	E	9		*	3	23	MLADE
ADE	75112219320083798	S14021	E	18		*	6	43	MLADE

ADE	75122023344983284 S13827 E	11	*	4	24 MLADE
ADE	760104205630131092S139234E	13	*	3	270MLADE
ADE	760110170031330950S139100E	15	*	3	310MLADE
ADE	760121110017433372S138481E	10	*	3	210MLADE
ADE	760122103106031499S138529E	10	*	3	180MLADE
ADE	760129095019030700S138680E	10	*	3	310MLADE
ADE	760205094706732022S138106E	11	*	4	210MLADE
ADE	760213211256130908S137365E	9	*	5	330MLADE
ADE	760227114450633296S138453E	7	*	6	360MLADE
ADE	760228065211029553S137101E	0	*	4	270MLADE
ADE	760312213034633944S138844E	26	*	4	240MLADE
ADE	760325040200931910S138725E	9	*	4	180MLADE
ADE	760331012611031292S138677E	7	*	4	300MLADE
ADE	760401002832236286S137408E	2	*	6	380MLADE
ADE	760402222807431159S138561E	5	*	4	230MLADE
ADE	760414073638131576S138596E	16	*	7	370MLADE
ADE	760424012257033955S135640E	12	*	4	300MLADE
ADE	760430041920032061S137802E	7	*	7	330MLADE
ADE	760501220101929432S137654E	11	*	3	290MLADE
ADE	760502084604537887S140662E	21	*	4	270MLADE
ADE	760508221133931582S138448E	8	*	5	270MLADE
ADE	760530171415031406S138734E	13	*	5	340MLADE
ADE	760610170925431947S138725E	9	*	4	250MLADE
ADE	760620055504132620S139261E	9	*	4	210MLADE
ADE	760707095151031916S139003E	12	*	4	230MLADE
ADE	760712134543737564S140451E	4	*	7	340MLADE
ADE	760714123427434869S139048E	9	*	4	220MLADE
ADE	760718204020633266S138488E	3	*	4	200MLADE
ADE	760720205022732894S138216E	13	*	4	240MLADE
ADE	760722092535831622S138328E	19	*	4	240MLADE

ADE	76081403471973766 8S139440E	31		*	7 400MLADE
ADE	7608140355469377O6S139422E	38		*	4 260MLADE
ADE	7608192048539320 68S138853E	7		*	5 230MLADE
ADE	760824104335431831S138546E	8		*	4 250MLADE
ADE	760826135758933585S136179E	9		*	3 240MLADE
ADE	760826140050533557S136226E	8		*	3 210MLADE
ADE	760903115109831228S138587E	1		*	4 270MLADE
ADE	760913044732032817S138288E	11		*	6 340MLADE
ADE	760916135719732804S138320E	14		*	3 210MLADE
ADE	760923185009731603S138564E	19		*	4 290MLADE
ADE	760927090351533471S138569E	9		*	4 230MLADE
ADE	761027055513633193S138478E	8		*	3 270MLADE
ADE	761028182035733490S136386E	7		*	4 300MLADE
ADE	761030042814533490S136404E	3		*	4 270MLADE
ADE	761031174032030974S138863E	12		*	4 260MLADE
ADE	761104013003432383S138802E	10		*	6 380MLADE
ADE	761130024707131259S138242E	15		*	4 310MLADE
ADE	761213165513032211S138103E	10		*	4 310MLADE
ADE	761220204109931084S138497E	14		*	4 330MLADE
ADE	761221044639932843S138280E	11		*	4 290MLADE
ADE	761221094926532151S138087E	13		*	4 280MLADE
ADE	770118190223932O4 S13821 E	17		*	3 22 MLADE
ADE	770129031635733 91 S13641 E	6		*	3 21 MLADE
ADE	770202150724130 67 S13815 E	5		*	3 22 MLADE
ADE	770219120253433 67 S13906 E	11		*	4 19 MLADE
ADE	770221230555631 93 S13857 E	12		*	3 23 MLADE
ADE	770222005824332 22 S13886 E	18		*	4 23 MLADE
ADE	770226070003135 59 S13749 E	9		*	4 30 MLADE
ADE	770304182140332 85 S13821 E	13	F	*	4 30 MLADE
ADE	770311022758429 15 S13469 E	6		*	4 30 MLADE

ADE	77032004003673278	S13824	E	1		*	4	29	MLADE
ADE	77041618192003244	S13796	E	5	F	*	6	38	MLADE
ADE	77042520215643495	S13757	E	11		*	4	27	MLADE
ADE	77051618235013212	S13876	E	9		*	5	22	MLADE
ADE	77052101394203269	S13831	E	16		*	4	18	MLADE
ADE	77052302435733203	S13830	E	10		*	3	18	MLADE
ADE	77060918171333232	S13926	E	4		*	4	27	MLADE
ADE	77072306044313245	S13802	E	11		*	5	27	MLADE
ADE	77072403335053358	S13656	E	8		*	4	23	MLADE
ADE	77082021552033491	S13889	E	22	F	*	5	29	MLADE
ADE	77083014134713104	S13846	E	12		*	9	39	MLADE
ADE	77090601224522895	S13857	E	26		*	6	29	MLADE
ADE	77091416382782715	S13552	E	26		*	5	29	MLADE
ADE	77091713344903446	S138	E	2		*	4	29	MLADE
ADE	77092204331363233	S13804	E	16		*	6	23	MLADE
ADE	77092300403753420	S13580	E	5		*	8	31	MLADE
ADE	77092509541833308	S13842	E	12		*	6	21	MLADE
ADE	77092819185533227	S13931	E	10	F	*	10	39	MLADE
ADE	77093100360703331	S13907	E	5		*	5	15	MLADE
ADE	77100303302053333	S13695	E	24		*	5	26	MLADE
ADE	77100306463403284	S13824	E	6		*	4	17	MLADE
ADE	77101407555383335	S13835	E	16	F	*	7	35	MLADE
ADE	77101409573713336	S13831	E	0		*	5	22	MLADE
ADE	77101819174373279	S13835	E	2		*	3	17	MLADE
ADE	77102106184843332	S13829	E	12		*	4	18	MLADE
ADE	77102901543293285	S13802	E	38		*	4	18	MLADE
ADE	77103000283923443	S13787	E	13		*	3	00	
ADE	77110111265823278	S13833	E	16		*	7	25	MLADE
ADE	77110122003083147	S13803	E	8		*	4	22	MLADE
ADE	77110412371333314	S13863	E	5	F	*	8	29	MLADE

ADE	77110422071083154	S13814	E	5	*	5	18	MLADE
ADE	77110705174033737	S13694	E	10	*	7	34	MLADE
ADE	77111712512653124	S13937	E	7	*	6	22	MLADE
ADE	77111816305463309	S13839	E	13	*	7	27	MLADE
ADE	77112007281273138	S13868	E	19	*	5	19	MLADE
ADE	77112116003903215	S13856	E	0	*	3	22	MLADE
ADE	77112116273543212	S13838	E	19	*	4	21	MLADE
ADE	77112215113923294	S13849	E	23	*	4	19	MLADE
ADE	77112914551003300	S13840	E	28	*	3	00	
ADE	77112915520333128	S13875	E	18	*	6	17	MLADE
ADE	77113005294283251	S13867	E	36	*	6	15	MLADE
ADE	77113007190753150	S13704	E	0	*	4	14	MLADE
ADE	77120111091243128	S13870	E	23	*	6	15	MLADE
ADE	77120117313783213	S13800	E	9	*	4	14	MLADE
ADE	77120210402713290	S13822	E	4	*	6	19	MLADE
ADE	77120323181913049	S13844	E	11	*	6	18	MLADE
ADE	77120415484513354	S13659	E	33	*	3	09	MLADE
ADE	77120714180213341	S13645	E	12	*	3	19	MLADE
ADE	77121109354403228	S13825	E	1	*	4	15	MLADE
ADE	77121117275663265	S13810	E	20	*	4	00	
ADE	77121402183283336	S13836	E	2	*	6	22	MLADE
ADE	77121409040303131	S13835	E	20	*	6	25	MLADE
ADE	77121414141323176	S13838	E	14	*	7	17	MLADE
ADE	77121503593553250	S13796	E	0	*	6	25	MLADE
ADE	77121611060383342	S13866	E	4	*	5	18	MLADE
ADE	77121612211073201	S13803	E	18	*	3	14	MLADE
ADE	77121614500153220	S13865	E	11	*	5	17	MLADE
ADE	77121709550213336	S13861	E	8	*	4	17	MLADE
ADE	77121807301203095	S13835	E	20	*	5	17	MLADE
ADE	77121810595373282	S13812	E	6	*	5	19	MLADE

ADE	77122022553133281 S13779 E	0				*	6	17	MLADE
ADE	77122619384893064 S13847 E	0				*	4	19	MLADE
ADE	780101183603232209S136245E	21		20	MN	*	3	19	MLADE
ADE	780109230423232112S137127E	0		12	MN	*	3	9	MLADE
ADE	780110043412230482S138727E	0		18	MN	*	3	17	MLADE
ADE	780113004337930473S138960E	0		18	MN	*	3	17	MLADE
ADE	780117010836932679S138470E	0		15	MN	*	4	13	MLADE
ADE	780117014510232025S138960E	0		26	MN	*	6	27	MLADE
ADE	780124053833432025S138707E	6		19	MN	*	4	18	MLADE
ADE	780129203415733065S138226E	24		17	MN	*	4	15	MLADE
ADE	780203034834831556S138977E	1		23	MN	*	6	23	MLADE
ADE	780203194800833213S138613E	11		19	MN	*	4	18	MLADE
ADE	780208003446931291S138679E	38		22	MN	*	6	22	MLADE
ADE	780209091355533346S138535E	20		22	MN	*	9	22	MLADE
ADE	780211021348133257S138216E	11		24	MN	*	9	25	MLADE
ADE	780213134900531362S138423E	6		20	MN	*	6	19	MLADE
ADE	780213213946734153S135945E	0		22	MN	*	6	22	MLADE
ADE	780216011436237123S139921E	34	F	27	MN	*	10	29	MLADE
ADE	780220065717131709S138707E	30		24	MN	*	10	25	MLADE
ADE	780223230443632307S138437E	16		15	MN	*	4	13	MLADE
ADE	780227113055833606S138603E	11		17	MN	*	3	15	MLADE
ADE	780306061344932864S138188E	9		25	MN	*	10	26	MLADE
ADE	780307192611333051S139588E	32		16	MN	*	4	14	MLADE
ADE	780309141511134389S139099E	19	F	30	MN	*	12	33	MLADE
ADE	780312021943433204S138558E	12		23	MN	*	10	23	MLADE
ADE	780313205151632945S138213E	0		15	MN	*	4	13	MLADE
ADE	780315042151731703S138713E	18		21	MN	*	8	21	MLADE
ADE	780315104632331827S137846E	18		14	MN	*	3	11	MLADE
ADE	780318000101533179S138543E	27		14	MN	*	4	11	MLADE
ADE	780320184458933503S139089E	17		18	MN	*	3	17	MLADE

ADE	780321000135832831S138152E	11		15	MN	*	3	13	MLADE
ADE	780321193257432312S138129E	12		15	MN	*	5	13	MLADE
ADE	780326223655432389S138923E	16	F	37	MN	*	14	42	MLADE
ADE	780402014406231554S138391E	14		26	MN	*	9	27	MLADE
ADE	780402230801832350S138905E	27		15	MN	*	3	13	MLADE
ADE	780403133115833121S138315E	16		13	MN	*	3	10	MLADE
ADE	780403135510232243S138038E	7		15	MN	*	3	13	MLADE
ADE	780405055134832082S138095E	17		16	MN	*	3	14	MLADE
ADE	780405191609333619S139018E	14		18	MN	*	4	17	MLADE
ADE	780406035257931447S138483E	17		20	MN	*	6	19	MLADE
ADE	780407020125332370S138945E	12		20	MN	*	5	19	MLADE
ADE	780413132126832704S138360E	7		17	MN	*	5	15	MLADE
ADE	780413174722534231S135693E	0		17	MN	*	6	15	MLADE
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ADE	780415002102332709S138090E	3		21	MN	*	9	21	MLADE
ADE	780418100056833351S138165E	19		14	MN	*	4	11	MLADE
ADE	780419180023232028S138512E	26		20	MN	*	8	19	MLADE
ADE	780422125920233371S138606E	14		14	MN	*	3	11	MLADE
ADE	780426091656030694S138254E	8		27	MN	*	7	29	MLADE
ADE	780426125041233239S138255E	14		19	MN	*	7	18	MLADE
ADE	780430191125532939S137841E	16		21	MN	*	9	21	MLADE
ADE	780502141740531074S138572E	11		15	MN	*	7	13	MLADE
ADE	780506175225733384S138595E	22		15	MN	*	4	13	MLADE
ADE	780506185616533156S138992E	9		15	MN	*	4	13	MLADE
ADE	780506214502633515S138827E	11		15	MN	*	3	13	MLADE
ADE	780507172156432623S138473E	17		20	MN	*	8	19	MLADE
ADE	780507172516132612S138497E	19		13	MN	*	3	10	MLADE
ADE	780508022213230774S138619E	31	F	33	MN	*	10	37	MLADE
ADE	780508222334131230S138518E	15		19	MN	*	6	18	MLADE
ADE	780509101714532098S138484E	31		14	MN	*	3	11	MLADE

ADE	78050918525763195IS138432E	14		25	MN	*	8	26	MLADE
ADE	780510085730332759S136655E	0		16	MN	*	4	14	MLADE
ADE	780511225548133254S138620E	11		16	MN	*	4	14	MLADE
ADE	780514164804433407S138527E	14		20	MN	*	6	19	MLADE
ADE	780514164828633453S138500E	3		17	MN	*	5	15	MLADE
ADE	780516104359433505S138755E	29		15	MN	*	3	13	MLADE
ADE	780516104503733455S138595E	1		22	MN	*	8	22	MLADE
ADE	780519200128633011S138372E	10		20	MN	*	5	19	MLADE
ADE	780521163106433512S138124E	0		15	MN	*	3	13	MLADE
ADE	780526183201733502S136750E	7		18	MN	*	4	17	MLADE
ADE	780529001350833493S136620E	4		22	MN	*	5	22	MLADE
ADE	780530134548833273S138248E	4		24	MN	*	9	25	MLADE
ADE	780601121412032884S138185E	6		12	MN	*	3	9	MLADE
ADE	780601140032231961S138711E	17		20	MN	*	6	19	MLADE
ADE	780602024218932804S138310E	19		20	MN	*	4	19	MLADE
ADE	780604164815332516S138335E	18		19	MN	*	4	18	MLADE
ADE	780606053451332742S138099E	24		14	MN	*	3	11	MLADE
ADE	780609034615631747S138796E	21		23	MN	*	7	23	MLADE
ADE	780609075828131401S138956E	0		18	MN	*	4	17	MLADE
ADE	780611225634231153S139262E	11		16	MN	*	3	14	MLADE
ADE	780615045023033116S138328E	4		20	MN	*	6	19	MLADE
ADE	780618110805734805S138767E	6	F	19	MN	*	9	18	MLADE
ADE	780620193353533475S138466E	27		14	MN	*	4	11	MLADE
ADE	780620194047231683S138613E	24		25	MN	*	8	26	MLADE
ADE	780621090154431586S138461E	23		13	MN	*	4	10	MLADE
ADE	780626135818132291S138398E	0		19	MN	*	3	18	MLADE
ADE	780626164424232531S138057E	12		22	MN	*	7	22	MLADE
ADE	780628162251932315S138232E	9		21	MN	*	6	21	MLADE
ADF	780628170253533512S138640E	24		18	MN	*	4	17	MLADE
ADE	780630150621532111S138239E	6		13	MN	*	3	10	MLADE

135

ADE	7807010925036329395138259E	0		15	MN	*	4	13	MLADE
ADE	780704013939333955S139323E	9		21	MN	*	5	21	MLADE
ADE	780705231538932898S138271E	0		18	MN	*	3	17	MLADE
ADE	780706202257732054S138024E	15		21	MN	*	3	21	MLADE
ADE	780710114056733441S138919E	9		16	MN	*	4	14	MLADE
ADE	780711230535632916S138220E	0		13	MN	*	3	10	MLADE
ADE	780717061558233377S136778E	26		25	MN	*	9	26	MLADE
ADE	780718113206832697S138116E	14		12	MN	*	3	9	MLADE
ADE	780720142755930814S138471E	9		18	MN	*	5	17	MLADE
ADE	780722225145330834S138479E	2		19	MN	*	5	18	MLADE
ADE	780725204256131631S138085E	22		20	MN	*	3	19	MLADE
ADE	780726191229731541S138725E	19		17	MN	*	4	15	MLADE
ADE	780727003125433458S136392E	10		16	MN	*	3	14	MLADE
ADE	780727145348233917S135815E	5	F	21	MN	*	5	21	MLADE
ADE	780728090826333439S139779E	2		20	MN	*	4	19	MLADE
ADE	780728191556032505S138850E	23		15	MN	*	4	13	MLADE
ADE	780729090146331447S138862E	8		17	MN	*	4	15	MLADE
ADE	780730021650333052S138215E	23		0	MN	*	4	6	MLADE
ADE	780731073336530887S137867E	14		19	MN	*	3	18	MLADE
ADE	780801085610634086S138883E	3		19	MN	*	3	18	MLADE
ADE	780803120944531127S138906E	13		27	MN	*	10	29	MLADE
ADE	780803133305131813S138521E	6		22	MN	*	7	22	MLADE
ADE	780805012309131199S138619E	20		18	MN	*	4	17	MLADE
ADE	780805052006332080S138673E	21		18	MN	*	3	17	MLADE
ADE	780807231854031292S139058E	22		18	MN	*	4	17	MLADE
ADE	780811124923932052S138856E	17		14	MN	*	4	11	MLADE
ADE	780814051009230071S138299E	35		15	MN	*	5	13	MLADE
ADE	780816143924333008S138317E	0		15	MN	*	3	13	MLADE
ADE	780816160620230825S139348E	31		13	MN	*	4	10	MLADE
ADE	780825151214235943S136659E	1		27	MN	*	11	29	MLADE

ADE	780826133136532669S138183E	34	16	MN	*	3	14	MLADE
ADE	780826234901732136S138892E	0	22	MN	*	3	22	MLADE
ADE	780827185652933106S138360E	19	14	MN	*	4	11	MLADE
ADE	780828051407432293S138533E	9	19	MN	*	5	18	MLADE
ADE	780831012804430939S136375E	18	28	MN	*	9	30	MLADE
ADE	780831180700933486S138477E	9	16	MN	*	3	14	MLADE
ADE	780901012515431228S138046E	24	17	MN	*	5	15	MLADE
ADE	780901022730534385S137908E	8	17	MN	*	5	15	MLADE
ADE	780908105442632911S138281E	27	15	MN	*	3	13	MLADE
ADE	780910132939432853S137527E	8	15	MN	*	3	13	MLADE
ADE	780914074908431277S138758E	33	13	MN	*	5	10	MLADE
ADE	780915010952731456S139019E	14	26	MN	*	10	27	MLADE
ADE	780917144254031510S138157E	2	19	MN	*	4	18	MLADE
ADE	780920012723231330S138650E	16	13	MN	*	4	10	MLADE
ADE	780920074614233334S138703E	21	15	MN	*	3	13	MLADE
ADE	780921072851230957S138436E	9	19	MN	*	4	18	MLADE
ADE	780925013029830640S138344E	19	19	MN	*	4	18	MLADE
ADE	780926180952233285S139376E	3	15	MN	*	4	13	MLADE
ADE	780927175733331544S138366E	28	15	MN	*	3	13	MLADE
ADE	780930141522333251S136521E	0	0	MN	*	3	6	MLADE
ADE	781003211233733084S138765E	0	22	MN	*	9	22	MLADE
ADE	781004021139732713S138250E	12	23	MN	*	9	23	MLADE
ADE	781004021814032765S138310E	0	18	MN	*	3	17	MLADE
ADE	781006080703933603S138499E	24	14	MN	*	4	11	MLADE
ADE	781006153627932680S138026E	23	0	MN	*	3	6	MLADE
ADE	781009005146932564S138203E	14	17	MN	*	3	15	MLADE
ADE	781009023250632827S138189E	17	18	MN	*	4	17	MLADE
ADE	781011171527831073S139415E	20	14	MN	*	4	11	MLADE
ADE	781012194413232626S138446E	7	23	MN	*	10	23	MLADE
ADE	781014031534833476S138566E	8	0	MN	*	4	6	MLADE

ADE	7810150716393329315138289E	18		25	MN	*	10	26	MLADE
ADE	7810151215568329445138284E	20		21	MN	*	6	21	MLADE
ADE	7810152312509329265138274E	21		16	MN	*	4	14	MLADE
ADE	7810160802331311225139224E	19		12	MN	*	4	9	MLADE
ADE	7810180229186344245137887E	1	E	15	MN	*	4	13	MLADE
ADE	7810191520030318855138563E	0		20	MN	*	5	19	MLADE
ADE	7810200344556316285138556E	14		23	MN	*	8	23	MLADE
ADE	7810200622565328815138246E	19		16	MN	*	4	14	MLADE
ADE	7810201843194320105138120E	1		18	MN	*	4	17	MLADE
ADE	7810230540368329105138261E	19		21	MN	*	6	21	MLADE
ADE	7810231201259318485138397E	5		18	MN	*	4	17	MLADE
ADE	7810241022044328995138233E	0		16	MN	*	4	14	MLADE
ADE	7810241809297315675138664E	9		17	MN	*	6	15	MLADE
ADE	7810242331058327315138158E	0		17	MN	*	3	15	MLADE
ADE	7810250152059335135138703E	22		19	MN	*	5	18	MLADE
ADE	7810290810154327555138254E	11		14	MN	*	3	11	MLADE
ADE	7810301805026324955138356E	6		22	MN	*	8	22	MLADE
ADE	7810312136587325005138359E	6		17	MN	*	3	15	MLADE
ADE	7811010029335335015136626E	1		22	MN	*	5	22	MLADE
ADE	7811011005563297015137833E	31		12	MN	*	4	9	MLADE
ADE	7811030132507326925135332E	11		17	MN	*	4	15	MLADE
ADE	7811032228190332055138239E	0		12	MN	*	4	9	MLADE
ADE	7811041158584326355138556E	9		19	MN	*	4	18	MLADE
ADE	7811050712208332615138630E	21		16	MN	*	3	14	MLADE
ADE	7811070958297334865136560E	19		20	MN	*	6	19	MLADE
ADE	7811111121581328215138195E	30		15	MN	*	5	13	MLADE
ADE	7811111941360333575138482E	0		14	MN	*	3	11	MLADE
ADE	7811131040050316745138421E	12		17	MN	*	4	15	MLADE
ADE	7811131113300932443S138239E	12		18	MN	*	3	17	MLADE
ADE	7811150754189320715138488E	0		21	MN	*	4	21	MLADE

ADE	7811171411369320515138281E	4			*	3	00	MLADE
ADE	781118045106332313S138417E	0	14	MN	*	3	11	MLADE
ADE	781118051138227992S136361E	19	28	MN	*	10	30	MLADE
ADE	781122130859531559S138592E	12	16	MN	*	5	14	MLADE
ADE	781128051407833518S138923E	12	13	MN	*	3	10	MLADE
ADE	781128201408333769S138351E	13	19	MN	*	6	18	MLADE
ADE	781129150222532803S136755E	0	12	MN	*	4	9	MLADE
ADE	781201124317936038S138527E	9	18	MN	*	7	17	MLADE
ADE	781201150157232589S138351E	37	9	MN	*	3	5	MLADE
ADE	781203145648133286S137108E	21	15	MN	*	4	13	MLADE
ADE	781205020131732790S137708E	28	15	MN	*	3	13	MLADE
ADE	781206014736733589S138855E	25	15	MN	*	3	13	MLADE
ADE	781207031321232834S138178E	32	12	MN	*	3	9	MLADE
ADE	781208031048332313S138761E	3	20	MN	*	5	19	MLADE
ADE	781208111846230997S139111E	22	12	MN	*	3	9	MLADE
ADE	781210193640133582S140067E	27	14	MN	*	4	11	MLADE
ADE	781212164020431233S138736E	6	18	MN	*	4	17	MLADE
ADE	781216100851828839S136380E	19	30	MN	*	10	33	MLADE
ADE	781217085945534076S135822E	10	19	MN	*	4	18	MLADE
ADE	781222055530133417S138563E	5	15	MN	*	3	13	MLADE
ADE	781222153512332330S138727E	28	15	MN	*	4	13	MLADE
ADE	781222190335033217S138275E	11	14	MN	*	4	11	MLADE
ADE	781224053803332424S138860E	26	11	MN	*	3	7	MLADE
ADE	781227182738932507S138460E	0	13	MN	*	3	10	MLADE
ADE	781227191314132286S138371E	5	16	MN	*	4	14	MLADE
ADE	781230023250132811S138545E	2	20	MN	*	6	19	MLADE
ADE	781230034915930374S138488E	4	23	MN	*	7	23	MLADE
ADE	790101010224032З1 S13815 E	20	16MN		*	6	14	MLADE
ADE	79010403153023358 S13856 E	6	17	MN	*	3	15	MLADE
ADE	79010406093123308 S13831 E	23	19	MN	*	5	18	MLADE

ADE	79010607202703353	S13859	E	6		20	MN	*	7	19	MLADE
ADE	79010608313953276	S13840	E	10		11	MN	*	4	07	MLADE
ADE	79010608444613236	S13814	E	6		17	MD	*	3	15	MLADE
ADE	79010708583553159	S13869	E	17		12	MN	*	4	09	MLADE
ADE	79010715333483274	S13822	E	10		29	MN	*	8	31	MLADE
ADE	79010816163613214	S13818	E	9		15	MN	*	3	13	MLADE
ADE	79011007421213320	S13846	E	9		19	MN	*	6	18	MLADE
ADE	79011015012083309	S13851	E	11		25	MN	*	10	26	MLADE
ADE	79011017070523181	S13814	E	20		13	MN	*	3	10	MLADE
ADE	79011107415863159	S13881	E	0		14	MN	*	4	11	MLADE
ADE	79011313385833756	S14036	E	16		21	MN	*	7	21	MLADE
ADE	79011709062683351	S13828	E	16		13	MN	*	3	10	MLADE
ADE	79011908413673249	S13822	E	27		12	MN	*	3	09	MLADE
ADE	79012107133703037	S13855	E14		E	21	MN	*	6	21	MLADE
ADE	79012111144943129	S13875	E	6		11	MN	*	3	07	MLADE
ADE	79012203214583127	S13926	E	5		25	MN	*	8	26	MLADE
ADE	79012322445223034	S13847	E	7		21	MN	*	6	21	MLADE
ADE	79012518093683269	S13768	E	19		17	MD	*	4	15	MLADE
ADE	79012619541673129	S13878	E	27		19	MD	*	4	18	MLADE
ADE	79012819443033366	S13881	E	27		19	MD	*	4	18	MLADE
ADE	79012919570243443	S13557	E	7		23	MN	*	9	23	MLADE
ADE	79013110230893447	S13574	E	19		21	MN	*	5	21	MLADE
ADE	79013110271493288	S13824	E	8		11	MN	*	3	07	MLADE
ADE	79013123414303444	S13561	E	10		21	MN	*	8	21	MLADE
ADE	79020418284253285	S13816	E	30		12	MN	*	3	09	MLADE
ADE	79020423085473448	S13553	E	10		22	MN	*	6	22	MLADE
ADE	79020514420923363	S13678	E	11		16	MN	*	4	14	MLADE
ADE	79020519000833122	S13863	E	21		24	MN	*	8	24	MLADE
ADE	79020709063473302	S13992	E	10		18	MN	*	3	17	MLADE
ADE	79021005135933345	S13846	E	16		21	MN	*	8	21	MLADE

ADE	79021006574923198	S13848	E	14	16	MN	*	5	14	MLADE
ADE	79021011443293134	S13868	E	18	19	MN	*	5	18	MLADE
ADE	79021606045183226	S13882	E	0	21	MN	*	5	21	MLADE
ADE	79021817240473357	S13605	E	18	20	MN	*	5	19	MLADE
ADE	79022108035903341	S13651	E	0	19	MN	*	4	18	MLADE
ADE	79022209250993037	S13948	E	17	22	MD	*	4	22	MLADE
ADE	79022719082873231	S13814	E	11	20	MD	*	4	19	MLADE
ADE	79030114482543174	S13845	E	12	18	MN	*	5	17	MLADE
ADE	79030418325383221	S13877	E	22	16	MN	*	4	14	MLADE
ADE	79030504160753260	S13849	E	6	08	MN	*	3	03	MLADE
ADE	79030605280073250	S13872	E	2	22	MN	*	5	22	MLADE
ADE	79030817032743329	S13861	E	20	20	MN	*	5	19	MLADE
ADE	79030900031313104	S13843	E	9	29	MN	*	10	31	MLADE
ADE	79030907105453328	S13675	E	27	15	MN	*	4	13	MLADE
ADE	79031506013233333	S13832	E	28	18	MN	*	3	17	MLADE
ADE	79031520041333241	S13865	E	6	31	MN	*	10	34	MLADE
ADE	79031607304463323	S13833	E	0	16	MD	*	4	14	MLADE
ADE	79031711405733272	S13803	E	32	14	MD	*	3	11	MLADE
ADE	79032013075533192	S13862	E	0			*	3	00	
ADE	79032206253172960	S13784	E	24	19	MN	*	4	18	MLADE
ADE	79032405081443127	S13879	E	4	23	MN	*	6	23	MLADE
ADE	79032405152183083	S13837	E	0			*	3	00	
ADE	79032814502073368	S13665	E	6	19	MN	*	5	18	MLADE
ADE	79032918360753209	S13810	E	10	16	MD	*	3	14	MLADE
ADE	79033112431043151	S13828	E	0	21	MN	*	3	21	MLADE
ADE	79040100473363348	S13868	E	3	21	MN	*	3	21	MLADE
ADE	79040105411883208	S13892	E	28	17	MN	*	3	15	MLADE
ADE	79040107522203446	S13846	E	7	18	MN	*	6	17	MLADE
ADE	79040113052493153	S13835	E	0	20	MN	*	4	19	MLADE
ADE	79040601283333236	S13829	E	8	24	MN	*	7	24	MLADE

ADE	79040607513133286	S13837	E	8	15	MD	*	3	13	MLADE
ADE	79040702300583127	S13825	E	6	17	MN	*	3	15	MLADE
ADE	79040704572863161	S13871	E	1	22	MN	*	6	22	MLADE
ADE	79040715052943220	S13846	E	9	14	MN	*	3	11	MLADE
ADE	79040810080503249	S13894	E	33	17	MN	*	4	15	MLADE
ADE	79041318023613290	S13825	E	14	12	MD	*	3	09	MLADE
ADE	79041715295093110	S13924	E	3	23	MN	*	5	23	MLADE
ADE	79042009594733027	S13855	E	31	19	MN	*	5	18	MLADE
ADE	79042315363223218	S13863	E	8	18	MD	*	3	17	MLADE
ADE	79042320544623306	S13825	E	31	15	MN	*	4	13	MLADE
ADE	79042400390443123	S13934	E	2	14	MN	*	4	11	MLADE
ADE	79042419122223331	S13833	E	19	15	MN	*	4	13	MLADE
ADE	79042505112153169	S13717	E	10	16	MN	*	3	14	MLADE
ADE	79042602061853321	S13829	E	11	12	MN	*	3	09	MLADE
ADE	79042904242353512	S13924	E	11	15	MN	*	4	13	MLADE
ADE	79043000071853149	S13828	E	0	19	MD	*	3	18	MLADE
ADE	79043012045653281	S13810	E	36	15	MD	*	4	13	MLADE
ADE	79050202455593318	S13827	E	17	15	MN	*	4	13	MLADE
ADE	79050408085563092	S13939	E	8	18	MN	*	4	17	MLADE
ADE	79050409384953095	S13948	E	9	19	MN	*	4	18	MLADE
ADE	79050415401613090	S13940	E	9	17	MN	*	3	15	MLADE
ADE	79050415414403093	S13935	E	9	16	MN	*	3	14	MLADE
ADE	79050420105563309	S13825	E	3	18	MN	*	4	17	MLADE
ADE	79050421590033093	S13942	E	10	15	MN	*	3	13	MLADE
ADE	79050506151762943	S13836	E	26	21	MN	*	6	21	MLADE
ADE	79050510074503117	S13918	E	6	19	MN	*	6	18	MLADE
ADE	79050512462213395	S13924	E	11	23	,M	*	6	23	MLADE
ADE	79050623021533093	S13949	E	8	18	MN	*	3	17	MLADE
ADE	79050723293173090	S13932	E	11	15	MN	*	3	13	MLADE
ADE	79050903032053188	S13936	E	4	17	MN	*	4	15	MLADE

ADE	79051322495633116	S13927	E	4	18	MN	*	4	17	MLADE
ADE	79051703024913191	S13858	E	12	13	MN	*	4	10	MLADE
ADE	79052622190653358	S13857	E	22	15	MN	*	3	13	MLADE
ADE	79052712291553144	S13828	E	7	14	MN	*	4	11	MLADE
ADE	79052803335093097	S13894	E	11	18	MN	*	4	17	MLADE
ADE	79052919420593383	S13833	E	9	18	MN	*	7	17	MLADE
ADE	79053010451003283	S13830	E	10	19	MN	*	6	18	MLADE
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ADE	79060118473693140	S13852	E	17	12	MN	*	5	09	MLADE
ADE	79060205431223233	S13817	E	12	11	MN	*	4	07	MLADE
ADE	79060314141853087	S13936	E	7	15	MN	*	3	13	MLADE
ADE	79060407313553197	S13830	E	20	17	MN	*	4	15	MLADE
ADE	79060419551722808	S13570	E	28	29	MN	*	9	31	MLADE
ADE	79060523264823117	S13809	E	8	14	MN	*	3	11	MLADE
ADE	79060715450973227	S13822	E	16	15	MN	*	4	13	MLADE
ADE	79060908015953276	S13817	E	18	16	MN	*	5	14	MLADE
ADE	79061000332502831	S14026	E	15	27	MN	*	12	29	MLADE
ADE	79061003182813161	S13863	E	12	17	MN	*	6	15	MLADE
ADE	79061022254583429	S13877	E	20	F26	MN	*	10	27	MLADE
ADE	79061304301933333	S13821	E	20	16	MN	*	6	15	MLADE
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ADE	79061518035123221	S13813	E	0	16	MD	*	4	15	MLADE
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ADE	79061913182923159	S13864	E	19	15	MN	*	3	13	MLADE
ADE	79062113101523384	S13576	E	0	18	MN	*	4	17	MLADE
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ADE	79062922445523327	S13866	E	4	12	MN	*	4	09	MLADE
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ADE	79070222275963167	S13720	E	3	11	MN	*	3	07	MLADE

ADE	79070408545983439	S13919	E	1	20	MN	*	9	19	MLADE
ADE	79070409184543439	S13919	E	4	F33	MN	*	14	37	MLADE
ADE	79071004293073323	S13869	E	5	19	MN	*	7	18	MLADE
ADE	79071203450143145	S13865	E	22	21	MN	*	7	21	MLADE
ADE	79071203570633140	S13849	E	5	22	MN	*	8	22	MLADE
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ADE	79071421111913306	S13943	E	6	25	MN	*	12	26	MLADE
ADE	79071515272793306	S13940	E	6	25	MN	*	12	26	MLADE
ADE	79071622420443166	S13722	E	20	13	MN	*	4	10	MLADE
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ADE	79071710450003346	S13948	E	18	14	MN	*	4	11	MLADE
ADE	79071823434653344	S13845	E	15	15	MN	*	4	13	MLADE
ADE	79071903245933151	S13925	E	6	26	MN	*	9	27	MLADE
ADE	79071909525483305	S13838	E	06	23	MN	*	11	19	MLADE
ADE	79072003043803331	S13708	E	11	17	MN	*	5	15	MLADE
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ADE	79072318101393307	S13945	E	1	14	MN	*	4	11	MLADE
ADE	79072812314403311	S13842	E	14	16	MN	*	4	15	MLADE
ADE	79072822362193318	S13829	E	7	14	MN	*	4	11	MLADE
ADE	79072907325423124	S13866	E	20	22	MN	*	9	22	MLADE
ADE	79072912190143318	S13828	E	0	11	MD	*	4	07	MLADE
ADE	79073023152093225	S13891	E	27	19	MN	*	8	18	MLADE
ADE	79073106325323289	S13823	E	20	13	MN	*	4	10	MLADE
ADE	79080300192953316	S13863	E	6	31	MN	*	14	34	MLADE
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ADE	79080301420722834	S13575	E	36	20	MN	*	6	19	MLADE
ADE	79080309490283199	S13847	E	30	14	MN	*	3	11	MLADE
ADE	79080513174853142	S13863	E	19	14	MN	*	6	11	MLADE

ADE	7908070835103335	S13832	E	12	12	MD	*	4	09 MLADE
ADE	7908090202413197	S13900	E	18	22	MN	*	8	22 MLADE
ADE	79080920202093230	S13942	E	0	20	MN	*	8	19 MLADE
ADE	79080920341323141	S13785	E	21	13	MN	*	4	10 MLADE
ADE	79081102483503227	S13871	E	0	17	MD	*	4	15 MLADE
ADE	79081114562853202	S13879	E	27	20	MN	*	8	19 MLADE
ADE	79081411402763250	S13834	E	16	23	MN	*	9	23 MLADE
ADE	79081508340653050	S13851	E	24	12	MN	*	3	09 MLADE
ADE	79081516340763372	S13645	E	5	22	MN	*	8	22 MLADE
ADE	79081601120122966	S13610	E	13	25	MN	*	9	26 MLADE
ADE	79081603514023285	S13866	E	0	15	MN	*	5	13 MLADE
ADE	79081809020563321	S13831	E	5	18	MN	*	5	17 MLADE
ADE	79081915234403234	S13820	E	11	20	MD	*	5	19 MLADE
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ADE	79082402240043281	S13816	E	23	13	MN	*	4	10 MLADE
ADE	79082404411613353	S13874	E	22	17	MN	*	3	15 MLADE
ADE	79082421021453151	S13912	E	19	20	MN	*	7	19 MLADE
ADE	79082823180353251	S13800	E	7	17	MD	*	4	15 MLADE
ADE	79082911150063230	S13833	E	26	17	MN	*	4	15 MLADE
ADE	79083018335913278	S13836	E	17	17	MD	*	4	15 MLADE
ADE	79083101144533492	S13805	E	29	18	MN	*	5	17 MLADE
ADE	79090101424893568	S13816	E	16	24	MN	*	10	25 MLADE
ADE	79090104111943209	S13846	E	21	15	MN	*	4	13 MLADE
ADE	79090200203743137	S13806	E	11	15	MN	*	4	13 MLADE
ADE	79090209450233137	S13839	E	0	20	MN	*	5	19 MLADE
ADE	79090509345413254	S13805	E	2	14	MN	*	4	11 MLADE
ADE	79090521093813168	S13718	E	9	15	MN	*	3	13 MLADE
ADE	79090621575183376	S13652	E	10	28	MN	*	12	30 MLADE
ADE	79090814524543349	S13873	E	21	19	MN	*	7	18 MLADE
ADE	79090818564833241	S13901	E	23	13	MN	*	4	10 MLADE

ADE	7909092007204334 1	S13929	E	4	17	MN	*	4	15	MLADE
ADE	79091110432003140	S13916	E	20	30	MN	*	13	33	MLADE
ADE	79091209352813313	S13871	E	4	F24	MN	*	10	24	MLADE
ADE	79091300015713229	S13820	E	15	15	MN	*	4	13	MLADE
ADE	79091321012293172	S13725	E	26	20	MD	*	3	19	MLADE
ADE	79091403290593361	S13866	E	28	14	MN	*	4	11	MLADE
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ADE	79091506090363271	S13825	E	7	19	MD	*	4	18	MLADE
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ADE	79091606271013151	S13869	E	14	16	MN	*	5	15	MLADE
ADE	79091620520683170	S13722	E	0	15	MN	*	3	13	MLADE
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ADE	79091801091033186	S13830	E	16	13	MN	*	4	10	MLADE
ADE	79092205374403141	S13867	E	17	25	MN	*	9	26	MLADE
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ADE	79092307115653260	S13830	E	29	14	MN	*	4	11	MLADE
ADE	79092420352003427	S13878	E	31	19	MN	*	6	18	MLADE
ADE	79092518501673156	S13793	E	0	15	MN	*	6	13	MLADE
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ADE	79092703143613330	S13919	E	18	14	MN	*	4	11	MLADE
ADE	79092720570773156	S13788	E	2	18	MN	*	6	17	MLADE
ADE	79092922282732971	S13785	E	23	19	MN	*	6	18	MLADE
ADE	79093006413673167	S13715	E	5	13	MN	*	3	10	MLADE
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ADE	79100717432893373	S13919	E	8	20	MN	*	4	19	MLADE
ADE	79100808282703321	S13921	E	1	24	MN	*	11	24	MLADE
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ADE	79101302415683170	S13715	E	7	19	MN	*	5	18	MLADE
ADE	79101409221243139	S13912	E	2	23	MN	*	8	23	MLADE
ADE	79101500444893335	S13842	E	10	13	MN	*	4	10	MLADE
ADE	79101502292053173	S13728	E	29	20	MD	*	4	19	MLADE
ADE	79101506241103227	S13904	E	11	15	MN	*	5	13	MLADE
ADE	79101507245363228	S13909	E	4	15	MN	*	5	13	MLADE
ADE	79101700125073298	S13821	E	29	17	MN	*	4	15	MLADE
ADE	79101804000163163	S13860	E	15	15	MN	*	5	13	MLADE
ADE	79101908122733166	S13718	E	15	18	MD	*	4	17	MLADE
ADE	79101909002883153	S13861	E	8	20	MD	*	5	19	MLADE
ADE	79102023534503150	S13697	E	0	18	MD	*	3	17	MLADE
ADE	79102211134033331	S13696	E	34	F37	MN	*	14	42	MLADE
ADE	79102316331473431	S14031	E	17	23	MN	*	4	23	MLADE
ADE	79102318545093238	S13892	E	0	F27	MN	*	12	29	MLADE
ADE	79102501492803153	S13839	E	6	20	MD	*	3	19	MLADE
ADE	79102711112923355	S13853	E	4	18	MN	*	4	17	MLADE
ADE	79102817225963165	S13884	E	0	17	MN	*	4	15	MLADE
ADE	79102904192243346	S13873	E	18	11	MN	*	4	07	MLADE
ADE	79103003251183302	S13750	E	5	12	MN	*	3	09	MLADE
ADE	79103119184353347	S13835	E	22	12	MN	*	4	09	MLADE
ADE	79103123293413169	S13721	E	0	19	MD	*	3	18	MLADE
ADE	79110122591893251	S13840	E	6	19	MN	*	6	18	MLADE
ADE	79110307453153168	S13719	E	18	15	MN	*	5	13	MLADE
ADE	79110414330943342	S13648	E	24	24	MN	*	8	24	MLADE
ADE	79110617475282995	S13813	E	8	17	MN	*	4	15	MLADE
ADE	79110908015433187	S13719	E	29	16	MN	*	3	14	MLADE
ADE	79110914435163242	S13835	E	9	12	MN	*	4	09	MLADE
ADE	79111009271363167	S13719	E	12	14	MN	*	4	11	MLADE
ADE	79111110454263199	S13822	E	0	21	MN	*	8	21	MLADE
ADE	79111115320103256	S13835	E	5	23	MN	*	10	23	MLADE

ADE	79111117564243165	S13852	E	1	13	MN	*	6	10	MLADE
ADE	79111222273483163	S13877	E	17	29	MN	*	10	31	MLADE
ADE	79111315161753375	S13855	E	14	19	MN	*	6	18	MLADE
ADE	79111500055033170	S13714	E	6	13	MN	*	4	10	MLADE
ADF	79111514180763348	S13868	E	15	18	MN	*	4	17	MLADE
ADF	79111609435223178	S13937	E	3	26	MN	*	12	27	MLADE
ADF	79111610420943170	S13928	E	2	14	MN	*	4	11	MLADE
ADE	79111803153963100	S13772	E	10	14	MN	*	3	11	MLADE
ADF	79111809382723279	S13768	E	10	18	MD	*	3	17	MLADE
ADE	79112115470233261	S13836	E	11	20	MD	*	4	19	MLADE
ADE	79112118530523368	S13858	E	2	17	MN	*	5	15	MLADE
ADE	79112408443133184	S13859	E	1	19	MN	*	6	18	MLADE
ADE	79112516265773000	S13790	E	13	16	MN	*	3	14	MLADE
ADE	79112516583073240	S13781	E	10	19	MD	*	3	18	MLADE
ADF	79112911511882968	S13806	E	19	23	MN	*	6	23	MLADE
ADE	79113017230983375	S13926	E	10	17	MN	*	6	15	MLADE
ADE	79120108031723158	S13732	E	29	18	MD	*	4	17	MLADE
ADE	79120307002743284	S13859	E	10	09	MN	*	4	05	MLADE
ADF	79120518460323240	S13885	E	27	11	MN	*	3	07	MLADE
ADE	79120720253823126	S13874	E	4	20	MN	*	7	19	MLADE
ADF	79120911294223340	S13930	E	4	15	MN	*	3	13	MLADE
ADE	79121015120223338	S13922	E	2	18	MN	*	6	17	MLADE
ADE	79121519520773170	S13720	E	27	10	MN	*	3	06	MLADE
ADE	79122115273443333	S13923	E	18	13	MN	*	3	10	MLADE
ADE	79122315481423435	S13938	E	10	22	MN	*	8	22	MLADE
ADE	79122321514503285	S13838	E	9	14	MN	*	4	11	MLADE
ADE	79122412440193285	S13816	E	18	18	MN	*	5	17	MLADE
ADE	79122418031373177	S13922	E	6	11	MN	*	3	07	MLADE
ADE	79122507064073286	S13828	E	25	19	MN	*	6	18	MLADE
ADF	79122923313533348	S13846	E	6	14	MN	*	3	11	MLADE

ADE	79123007191093117	S13945	E	13	13	MN	*	3	10	MLADE
ADE	79123008145433193	S13849	E	11	15	MN	*	5	13	MLADE
ADE	79123009342163345	S13689	E	10	17	MN	*	5	15	MLADE
ADE	79123010500923140	S13832	E	19	13	MN	*	5	10	MLADE
ADE	79123113352153117	S13942	E	17	15	MN	*	5	13	MLADE

APPENDIX C

RISK ANALYSIS RESULTS AND EFFECTS OF VARYING RISK PARAMETERS

Legend for figures C1 to C10

A)
1) refer to the seismic zones of AS 2121-1979
2)

ANSRW	=	Recurrence relationship derived by Average Numbers Square Root Weighted method.
MLM	=	Recurrence relationship derived by Maximum Likelihood Method.
Esteva 1973	=	Velocity attenuation equation of Esteva derived in 1973 (see main text).
HBB	=	Velocity attenuation equation of Hasegawa Basham and Berry (see main text).
W	=	Western Canada version of HBB.
E	=	Eastern Canada version of HBB.
MCG	=	Velocity attenuation relationship of McGuire derived in 1978 for soil site (see main text).
Adelaide	=	a site at 34.933°S 138.6°E.
Port Augusta	=	a site at 32.549°S 137.783°E.
wrong Adelaide Geosyncline	=	an area bounded by 30.389°S, 36.059°S, 140.030°E and 137.783°E.
Port Augusta local	=	an area bounded by 30.389°S, 34.709°S, 140.351°E and 135.215°E.
Adelaide local	=	an area bounded by 32.773°S, 37.093°S, 141.168°E and 136.032°E.

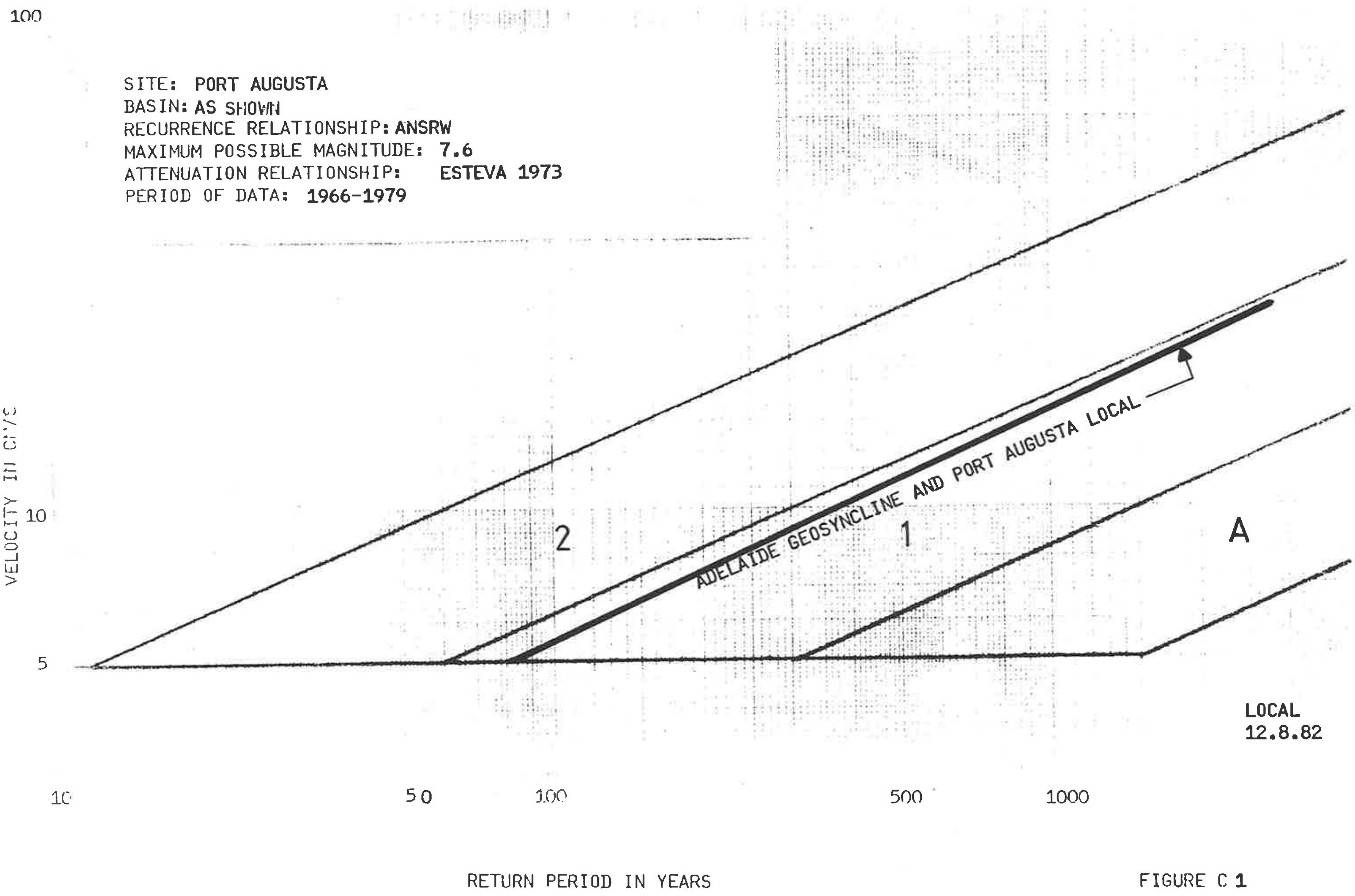
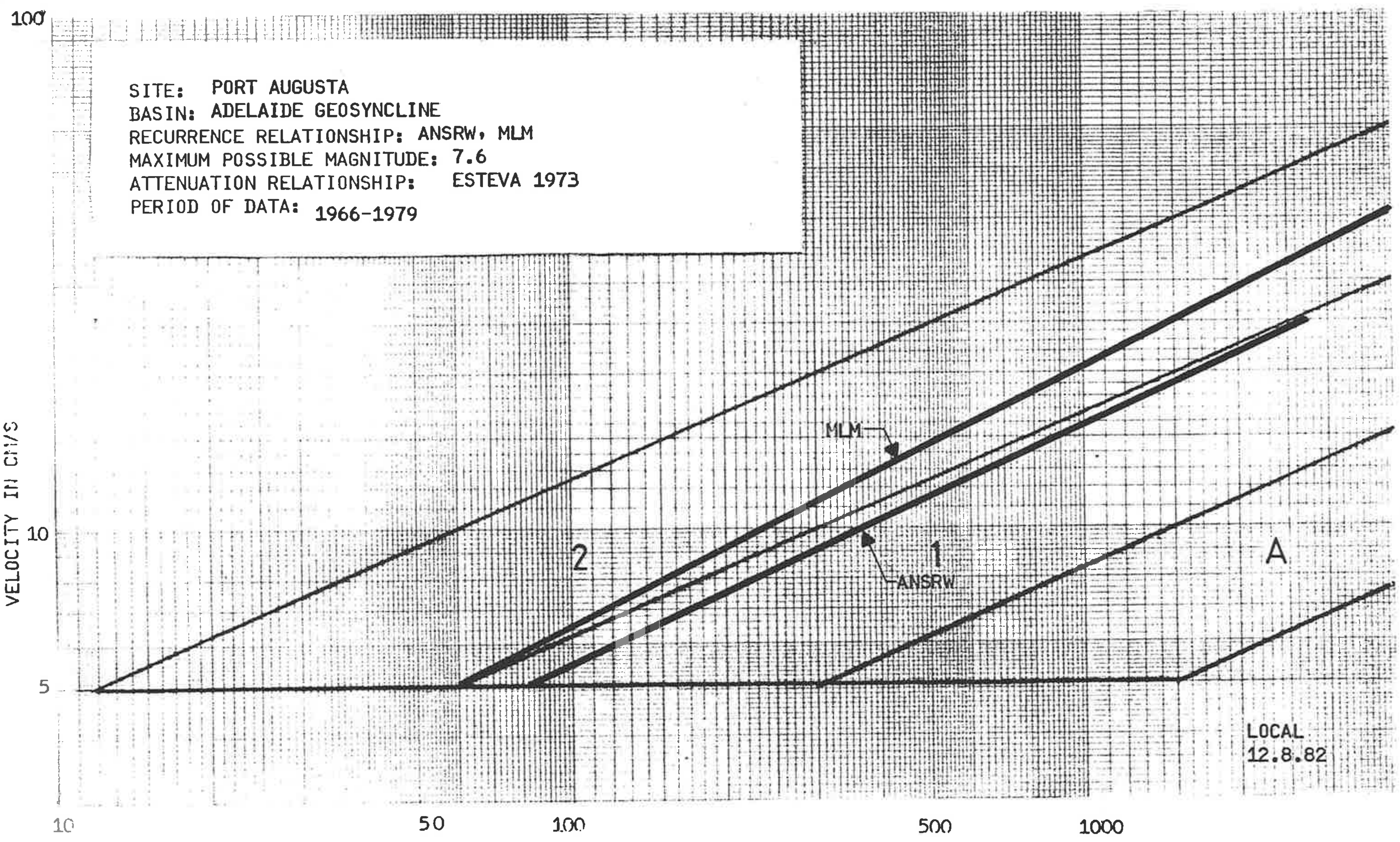
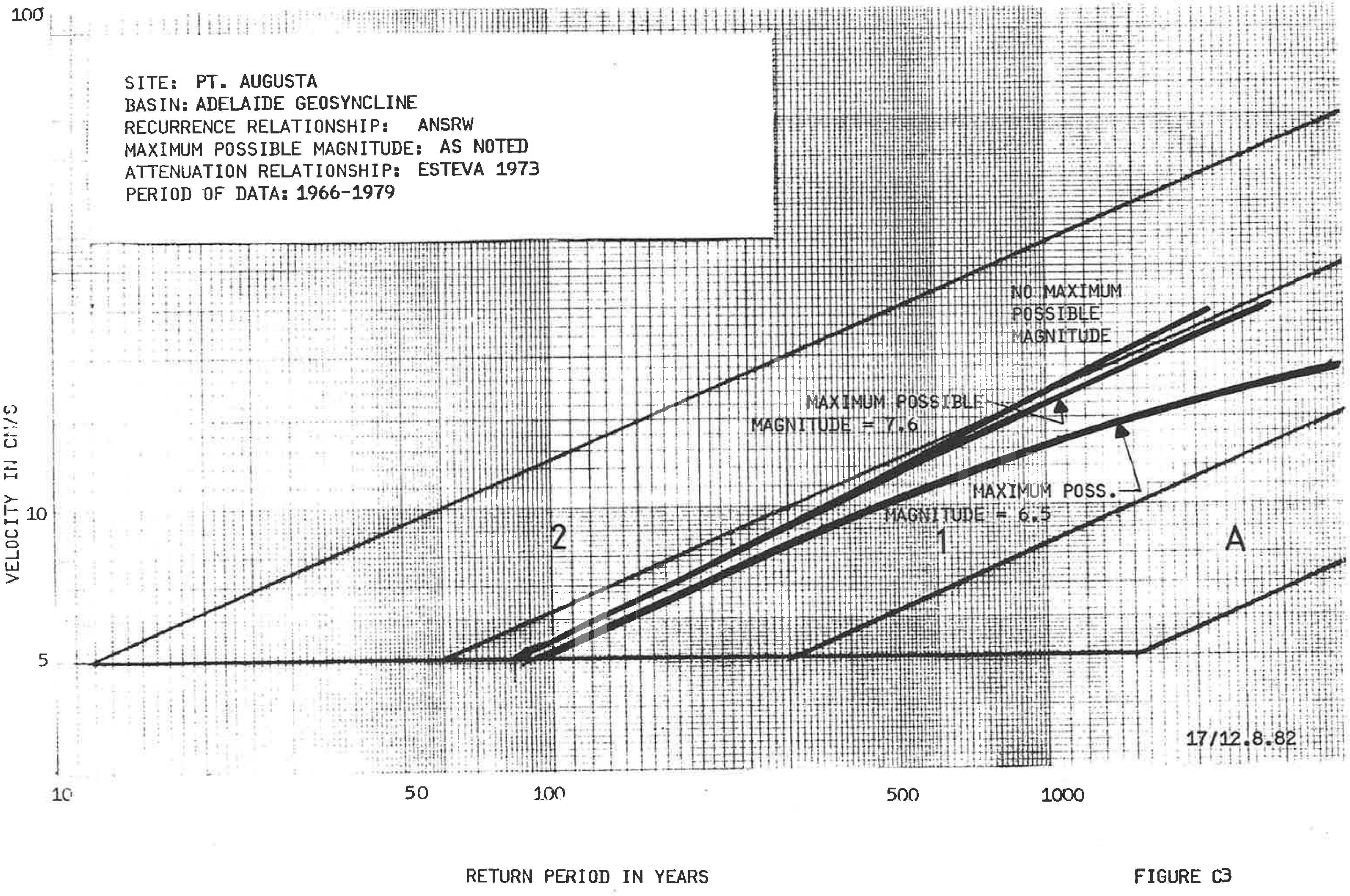

SITE: PORT AUGUSTA
BASIN: AS SHOWN
RECURRENCE RELATIONSHIP: ANSRW
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: 1966-1979
100
10
5
VELOCITY IN CM/S
2
1
A
ADELAIDE GEOSYNCLINE AND PORT AUGUSTA LOCAL
LOCAL
12.8.82
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE C 1



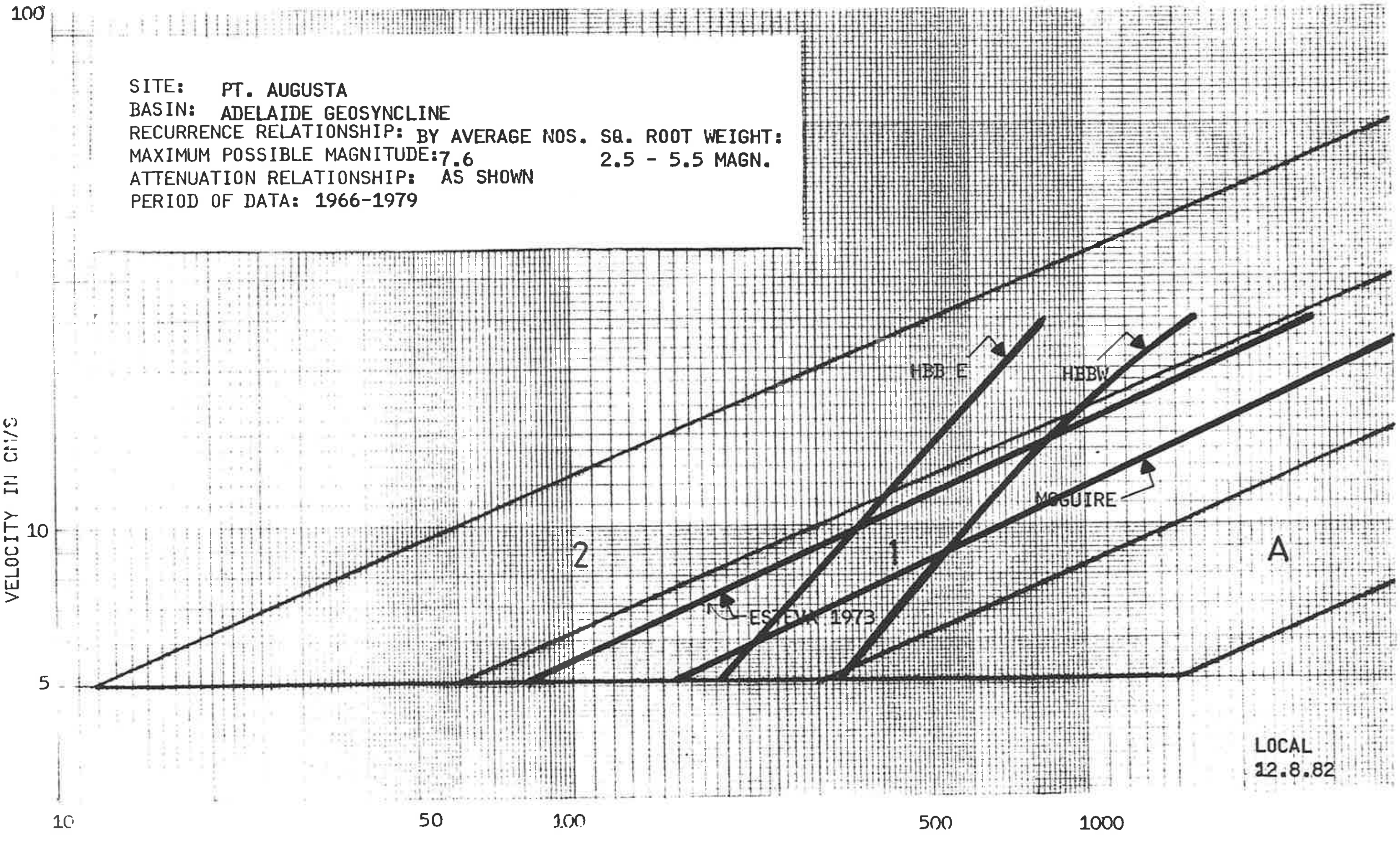
RETURN PERIOD IN YEARS

FIGURE C2



SITE: PT. AUGUSTA
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW
MAXIMUM POSSIBLE MAGNITUDE: AS NOTED
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: 1966-1979
NO MAXIMUM POSSIBLE MAGNITUDE
MAXIMUM POSSIBLE MAGNITUDE = 7.6
MAXIMUM POSS. MAGNITUDE = 6.5
2
1
A
17/12.8.82
VELOCITY IN CM/S
100
10
5
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE C3



SITE: PT. AUGUSTA
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: BY AVERAGE NOS. SQ. ROOT WEIGHT:
MAXIMUM POSSIBLE MAGNITUDE: 7.6
2.5 - 5.5 MAGN.
ATTENUATION RELATIONSHIP: AS SHOWN
PERIOD OF DATA: 1966-1979
VELOCITY IN CM/S
100
10
5
10
50
100
500
1000
HBB E
HBBW
MCGUIRE
ESTEVA 1973
2
1
A
LOCAL
12.8.82
RETURN PERIOD IN YEARS

FIGURE C4

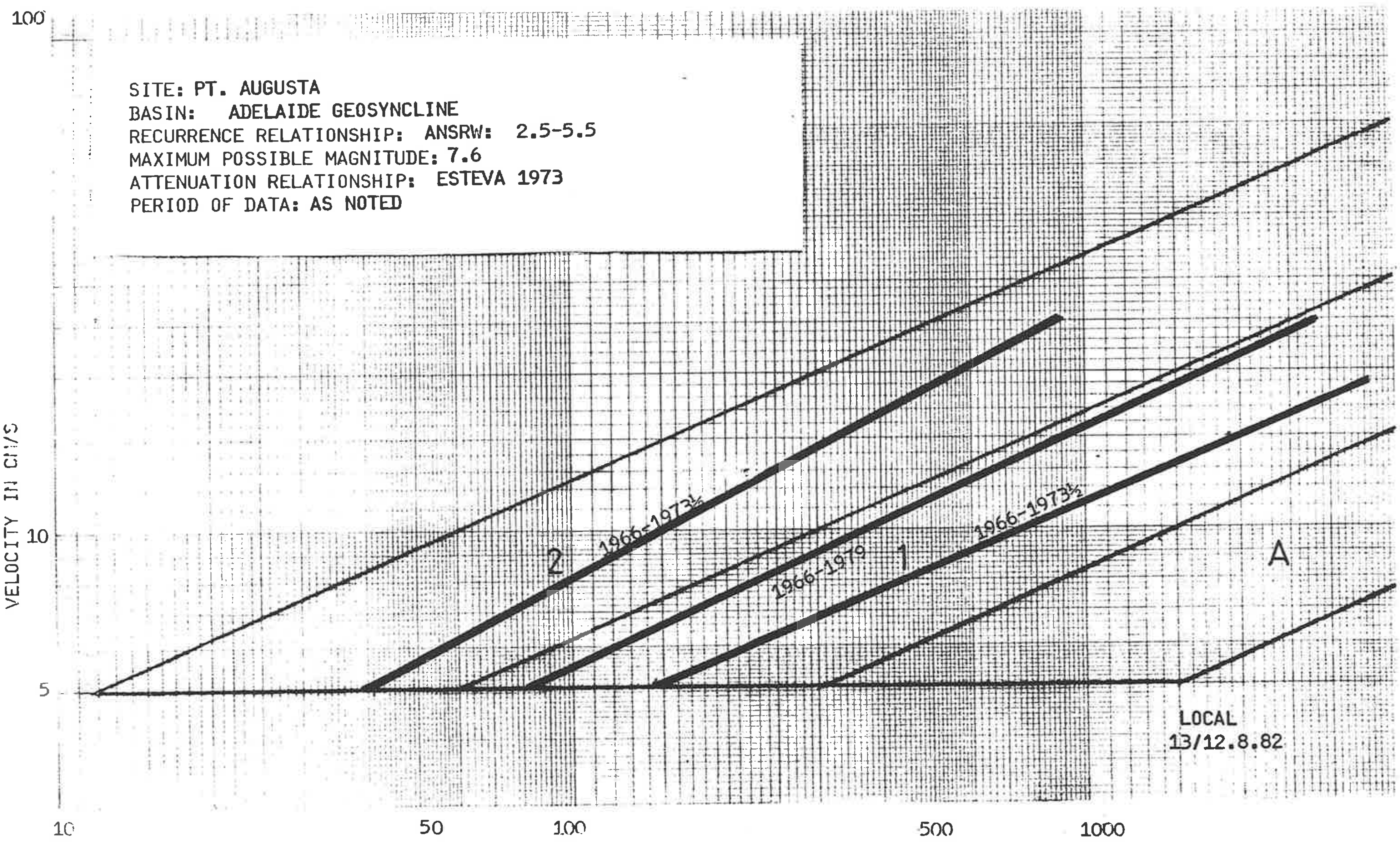

SITE: PT. AUGUSTA
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW: 2.5-5.5
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: AS NOTED
VELOCITY IN CM/S
100
10
5
2
1966-1973½
1966-1979
1
1966-1973½
A
LOCAL
13/12.8.82
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE C 5

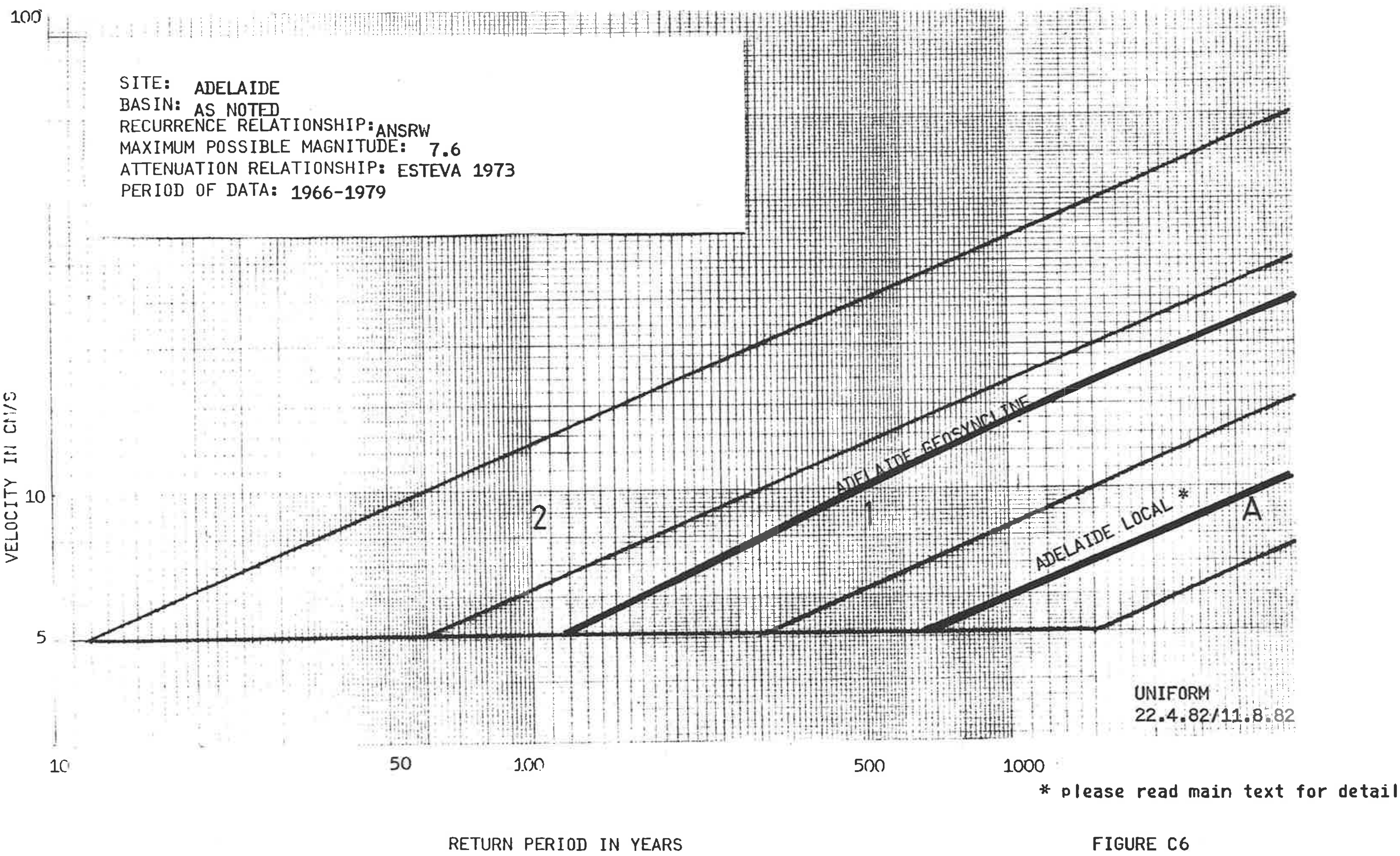

SITE: ADELAIDE
BASIN: AS NOTED
RECURRENCE RELATIONSHIP: ANSRW
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: 1966-1979
VELOCITY IN CM/S
100
10
5
2
ADELAIDE GEOSYNCLINE
1
ADELAIDE LOCAL *
A
UNIFORM
22.4.82/11.8.82
10
50
100
500
1000
* please read main text for detail
RETURN PERIOD IN YEARS

FIGURE C6

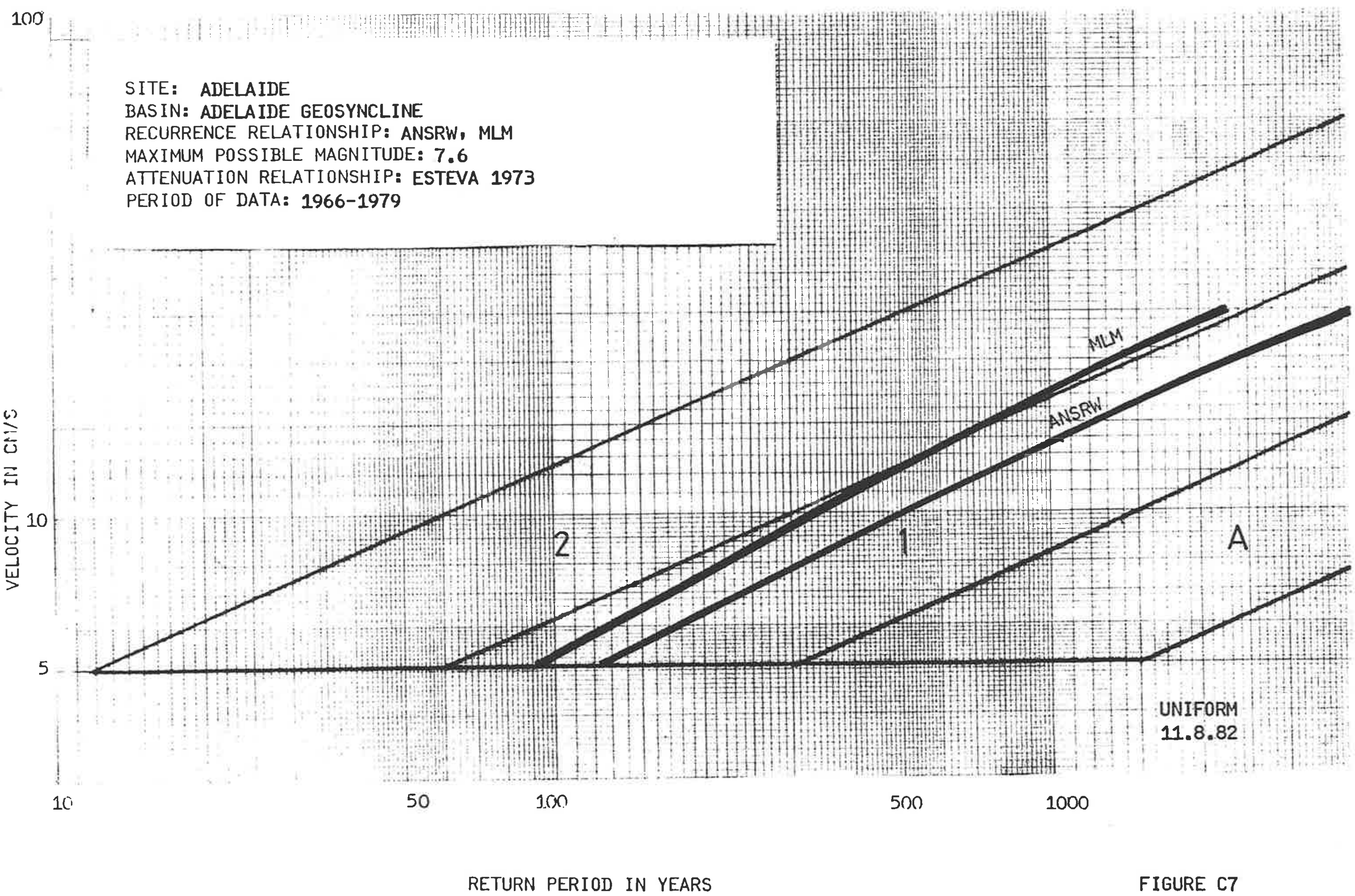
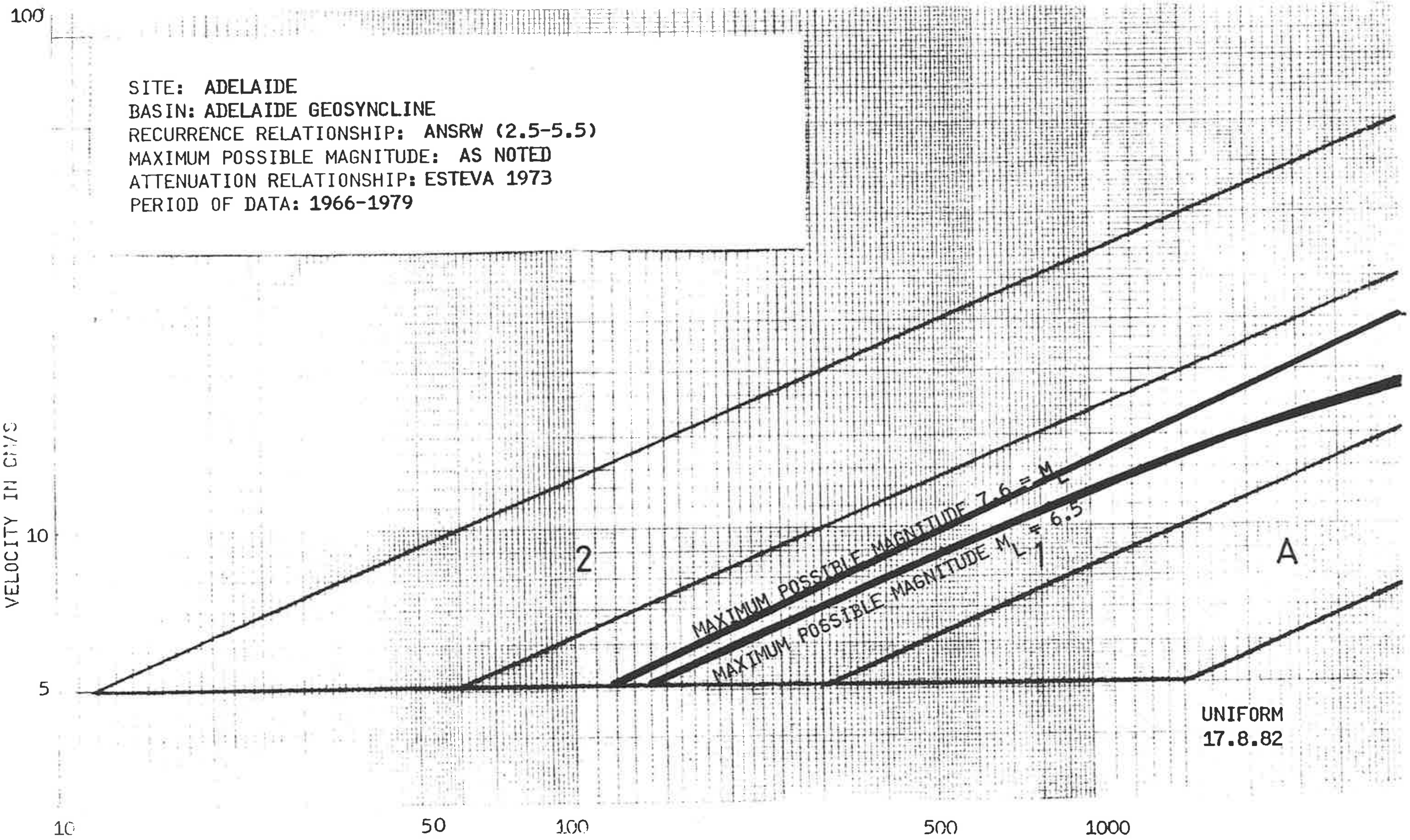

SITE: ADELAIDE
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW, MLM
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: 1966-1979
100
10
5
VELOCITY IN CM/S
MLM
ANSRW
2
1
A
UNIFORM
11.8.82
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE C7



RETURN PERIOD IN YEARS

FIGURE C8

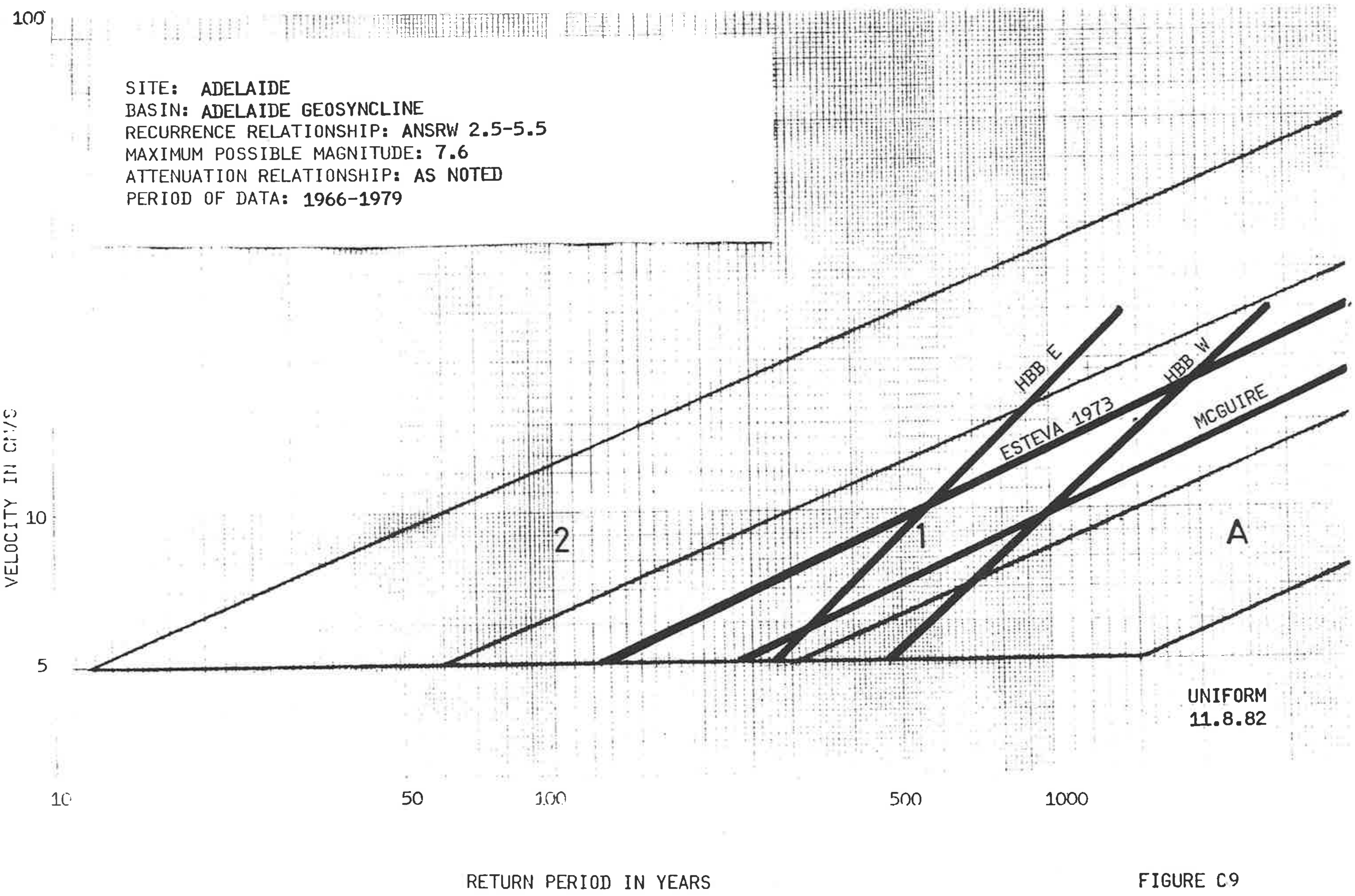

SITE: ADELAIDE
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW 2.5-5.5
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: AS NOTED
PERIOD OF DATA: 1966-1979
100
10
5
VELOCITY IN CM/S
10
50
100
500
1000
RETURN PERIOD IN YEARS
HBB E
HBB W
ESTEVA 1973
MCGUIRE
2
1
A
UNIFORM
11.8.82

FIGURE C9

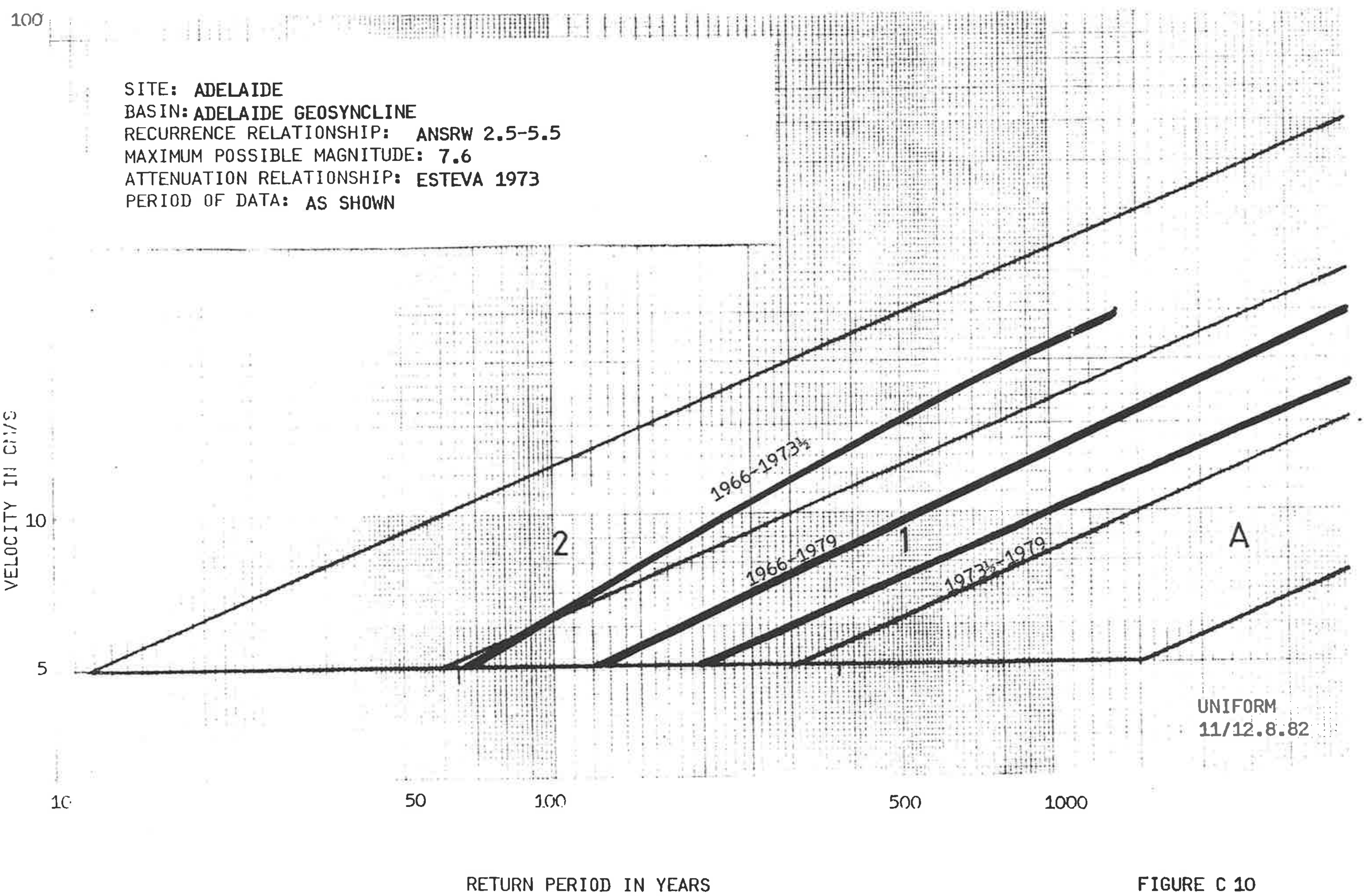

SITE: ADELAIDE
BASIN: ADELAIDE GEOSYNCLINE
RECURRENCE RELATIONSHIP: ANSRW 2.5-5.5
MAXIMUM POSSIBLE MAGNITUDE: 7.6
ATTENUATION RELATIONSHIP: ESTEVA 1973
PERIOD OF DATA: AS SHOWN
100
10
5
VELOCITY IN CM/S
1966-1973½
1966-1979
1973½-1979
2
1
A
UNIFORM
11/12.8.82
10
50
100
500
1000
RETURN PERIOD IN YEARS

FIGURE C 10

APPENDIX D

RISK ANALYSIS BY AN HISTORICAL RECORD METHOD FOR THE ADELAIDE SITE

D.1 Data on seismic ground motions in Adelaide

Up until 1982 using the historical data from isoseismals (Figures 4.5 to Figures 4.13 inclusive) at the Adelaide site the following approximate intensities have been recorded:

1902 Warooka approximate intensity VI.

1954 Adelaide intensity V or VI.

1897 Kingston intensity IV.

1883 Mount Barker intensity IV.

Using Newmark and Rosenblueths (1971) conversion $I = \frac{\log 14V}{\log 2}$ to velocity.

intensity VI = 4.6 cm/s.

intensity V = 2.3 cm/s.

intensity IV = 1.1 cm/s.

Assuming the above data is for the 146 years that Adelaide has been settled and is complete then:

on one occasion 4.6 cm/sec velocity

on two occasions 2.3 cm/sec velocity or greater

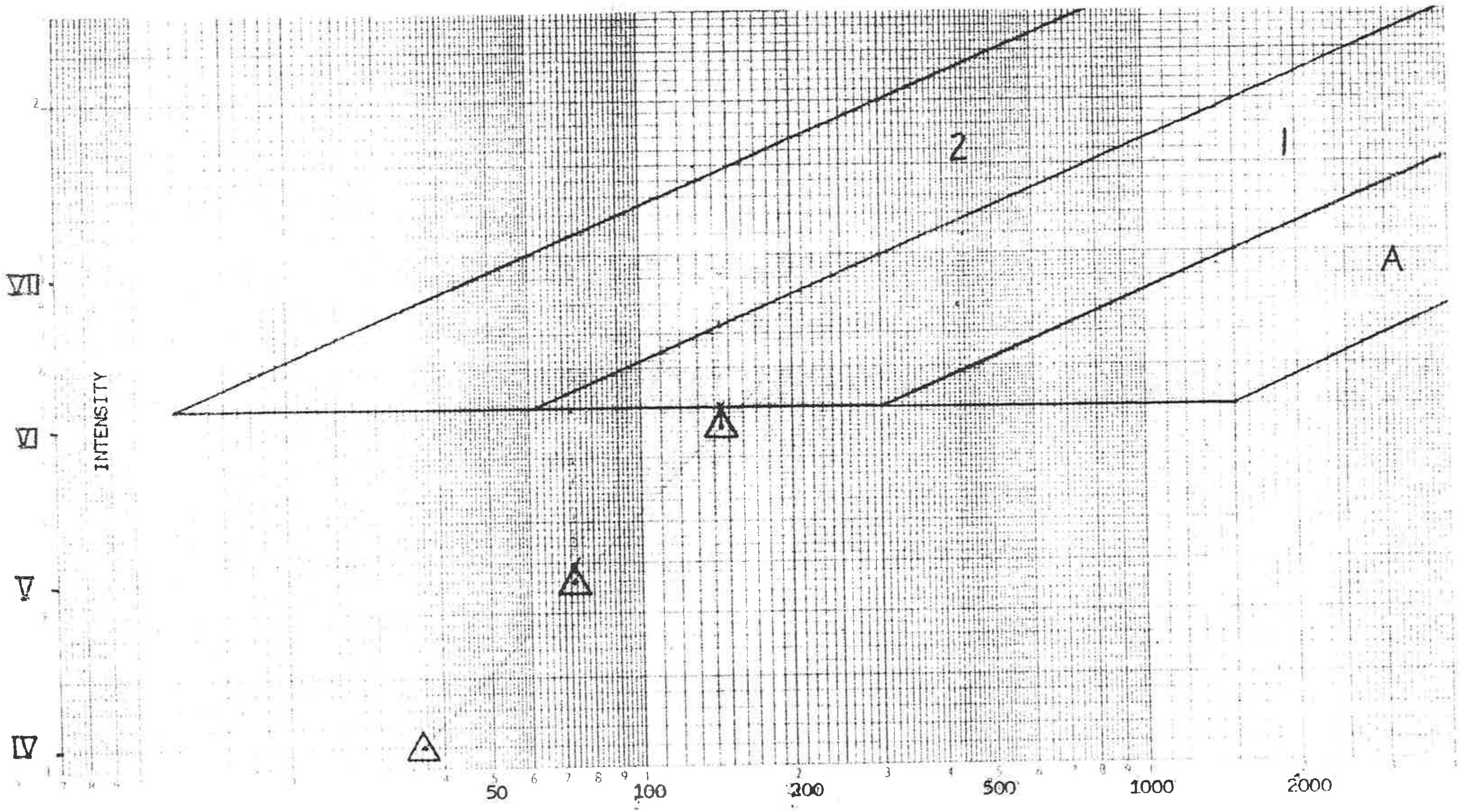
on four occasions 1.1 cm/sec velocity or greater

4.6 cm/sec = 146 yr. return period

2.3 cm/sec = 73 yr. return period

1.1 cm/sec = 36.5yr. return period

This data is plotted on figure D.1.



RETURN PERIOD IN YEARS

FIGURE D1

APPENDIX E

SOURCE LISTING OF PROGRAM ROSIE

```
      PROGRAM ROS1EH(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      ROS1EH
      INTEGER EQNMAX,EQNTYP
      REAL MMAX,LATMAX,LATMIN,LONMAX,LONMIN,MLL,MLU,JJ,MS,MLLL
      REAL LAT(1400),LON(1400),MAG(1400)
      REAL LATSTA,LONSTA,LATUL,LONUL,LATLL,LONLL
      DIMENSION REF(1400),EQ(1400),NAM(7)
      READ(5,10)LATMAX,LATMIN,LONMAX,LONMIN,(NAM(I),I=1,7)
      READ(5,10)DLAT,DLON,DEPTH,CO
      READ(5,20)EQNMAX,MMAX,NQ,YL,YU,CI,MLL,MLU,MLLL
 10   FORMAT(4F10.3,8A5)
 20   FORMAT(I10,F10.3,I10,2F10.4,4F5.2)
      WRITE(6,25)
 25   FORMAT(/40H      LATMAX     LATMIN     LONMAX     LONMIN)
      WRITE(6,10)LATMAX,LATMIN,LONMAX,LONMIN,(NAM(I),I=1,7)
 43   CONTINUE
      RMQ=MLL
      WRITE(6,35)
 35   FORMAT(/50H       DLAT       DLON      DEPTH         CO        RMQ)
      WRITE(6,40)DLAT,DLON,DEPTH,CO,RMQ
 40   FORMAT(5F10.3)
      WRITE(6,41)
 41   FORMAT(/30H         CI        MLL        MLU)
      WRITE(6,42)CI,MLL,MLU
 42   FORMAT(3F10.3)
      YR1=YU-YL
      YR=AINT(YR1)+AINT((YR1-AINT(YR1))*100.)/12.
      WRITE(6,45)
 45   FORMAT(/58H     EQNMAX  MLL  MLU      MMAX          NQ    YEARS OF REC
     +ORD)
      WRITE(6,50)EQNMAX,MLL,MLU,MMAX,NQ,YR,YL,YU
 50   FORMAT(I10,2F5.2,F10.3,I10,F10.4,2X,≠(≠,F7.4,≠ TO ≠,F7.4,≠)≠)
      PIXELS=(LATMAX-LATMIN)*(LONMAX-LONMIN)/(DLON*DLAT)
      M=0
      MM=0
      RM=0.0
      DO 100 I=1,NQ
      READ(5,60)JJ,RK,RL,RN
 60   FORMAT(6X,BZ,F10.6,3X,F5.3,1X,F6.3,41X,F3.2,5X)
      IF(JJ.LT.69)GO TO 51
      RN=0.79*RN+0.58
 51   ~~CONTINUE~~
      RK=-RK
      IF(JJ.GE.YL.AND.JJ.LE.YU)GO TO 201
      GO TO 100
 201  IF(RK.GE.LATMIN.AND.RK.LT.LATMAX)GO TO 80
      GO TO 100
 80   IF(RL.GE.LONMIN.AND.RL.LT.LONMAX)GO TO 90
      GO TO 100
 90   IF(RN.LT.RMQ)GO TO 91
      MM=MM+1
      RM=RM+RN
 91   M=M+1
      REF(M)=JJ
      LAT(M)=RK
      LON(M)=RL
      MAG(M)=RN
 100  CONTINUE
      N=M
      RMB=RM/MM
      RMO=RMQ-0.05
      WRITE(6,92)RMB,RM,MM
 92   FORMAT(2X,2F10.3,I10)
      UBAR=0.1/ALOG(1+0.1/(RMB-RMO))
      WRITE(6,102)UBAR
 102  FORMAT(F10.3)
      RLAMB=(MM/YR)*EXP(RMO/UBAR)
      WRITE(6,120)M,RMB,RMO,UBAR,RLAMB,RM,MM
 120  FORMAT(//11H BASIN HAS ,I5,13H QUAKES IN IT,//≠       RMB        RMO
     +     UBAR     RLAMB          RM          MM≠,/5F10.3,I10)

      L=0
      S=0.0
      SUMX=0.0
      SUMY=0.0
      SUMY2=0.0
      SUMXY=0.0
```

```
      SUMX2=0.0
      SUMM=0.0
      IF(S.LT.MLL)F=MLL
      GO TO 204
  200 CONTINUE
      F=S+CI
      IF(S.GE.(MLU-0.0001))GO TO 101
  204 CONTINUE
      J=0
      L=L+1
      DO 104 I=1,N
      IF(MAG(I).GE.S.AND.MAG(I).LT.F)GO TO 103
      GO TO 104
  103 J=J+1
      EQ(J)=REF(I)
  104 CONTINUE
      WRITE(6,1000)S,F
 1000 FORMAT(/3H S=,F10.3,3H F=,F10.3)
      IF(J.EQ.0)GO TO 107
      WRITE(6,2000)(EQ(I),I=1,J)
 2000 FORMAT(10F13.6)
  107 M=M-J
      T=M/YR
      IF(T.EQ.0.0)GO TO 101
      TLOG=ALOG10(T)
      WRITE(6,3000)F,J,M,T
 3000 FORMAT(3H F=,F5.1,3H J=,I5,3H M=,I5,3H T=,F8.3)
      MS = SQRT(FLOAT(M))
      SUMX=SUMX+F*MS
      SUMY=SUMY+TLOG*MS
      SUMY2=SUMY2+MS*TLOG**2
      SUMXY=SUMXY+MS*F*TLOG
      SUMX2=SUMX2+MS*F**2
      SUMM=SUMM+MS
      IF(S.LT.MLL)GO TO 205
      S=S+CI
      GO TO 200
  205 S=MLL
      GO TO 200
  101 CONTINUE
      IF(T.GT.0.0)GO TO 1002
      WRITE(6,1001)S
 1001 FORMAT(24H MAGNITUDE UPPER LIMIT =,F10.3)
 1002 CONTINUE
      SLOPE=(SUMXY-(SUMX*SUMY/SUMM))/(SUMX2-(SUMX**2/SUMM))
      YINT=(SUMY-SLOPE*SUMX)/SUMM
      SLO=ABS(SLOPE)
      SIGX=SQRT((SUMX2-SUMX*SUMX/SUMM)/(SUMM-1))
      SIGY=SQRT((SUMY2-SUMY*SUMY/SUMM)/(SUMM-1))
      CORR=SLOPE*SIGX/SIGY
      RLE=ALOG(RLAMB)
      RU=1./UBAR
      AM=ALOG10(RLAMB)
      BM=0.4343/UBAR
      WRITE(6,4000)YINT,SLO,CORR
 4000 FORMAT(//34H THE RECURRENCE RELATIONSHIP IS S=,//17H         LOG(NC/
     +T)=,F4.2,1H-,F4.2,2HML,//31H THE CORRELATION COEFFICIENT IS,/T10,F
     +10.7)
      WRITE(6,5000)RLE,RU
 5000 FORMAT(//18H      (LOGE(NC/T)=,F4.2,1H-,F4.2,3HML))
      WRITE(6,5010)AM,BM
 5010 FORMAT(22H A BY MAX LIKELIHOOD =,F10.3,/22H B BY MAX LIKELIHOOD =,
     +F10.3)
      WRITE(6,5011)MLL,MLU
 5011 FORMAT(2F10.3)
      MLL=MLL+0.1
      IF(MLL.LE.MLLL)GO TO 43
      READ(5,65)LATSTA,LONSTA,(NAM(I),I=1,7)
      WRITE(6,61)
   61 FORMAT(/20H    LATSTA     LONSTA)
   65 FORMAT(2F10.3,5X,7A5)
      WRITE(6,65)LATSTA,LONSTA,(NAM(I),I=1,7)
      DO 799 L=1,EQNMAX
      READ(5,700)EQNTYP,Y,DY,YMAX
  700 FORMAT(I10,3F10.3)
      WRITE(6,702)
  702 FORMAT(/40H    EQNTYP         Y          DY        YMAX)
```

```
      WRITE(6,700)EQNTYP,Y,DY,YMAX
701   IF(EQNTYP.EQ.1)GO TO 64
      IF(EQNTYP.EQ.2)GO TO 66
      IF(EQNTYP.EQ.3)GO TO 68
      IF(EQNTYP.EQ.4)GO TO 761
      IF(EQNTYP.EQ.5)GO TO 763
      IF(EQNTYP.EQ.6)GO TO 765
      WRITE(6,59)
 59   FORMAT(/18H SILLY EQNTYP USED)
      GO TO 63
 64   WRITE(6,62)Y
 62   FORMAT(/42H ESTEVA 1973 VELOCITY ATTENUATION FOR VEL=,F10.3)
      GO TO 63
 68   WRITE(6,69)Y
 69   FORMAT(/31H MCGUIRE 1978 VELOCITY FOR VEL=,F10.3)
      GO TO 63
761   WRITE(6,762)Y
762   FORMAT(/32H FACCIOLI 1978 VELOCITY FOR VEL=,F10.3)
      GO TO 63
763   WRITE(6,764)Y
764   FORMAT(/33H WESTERN CANADA HBB 1981 FOR VEL=,F10.3)
      GO TO 63
765   WRITE(6,766)Y
766   FORMAT(/33H EASTERN CANADA HBB 1981 FOR VEL=,F10.3)
      GO TO 63
 66   WRITE(6,67)Y
 67   FORMAT(/48H ESTEVA 1973 ACCELERATION ATTENUATION FOR ACCEL=,F10.3)
 63   WRITE(6,445)
      PROB=0.0
      PROB1=1.0
      PROB2=1.0
      PROB3=1.0
      PROB4=0
445   FORMAT(/61H      SSLAT      SSLON          K          Q          RML
     +      Q1)
      LATUL=LATMAX-DLAT/2
      LONUL=LONMAX-DLON/2
      LATLL=LATMIN+DLAT/2
      LONLL=LONMIN+DLON/2
      SSLAT=LATLL
      SSLON=LONLL
300   IF(SSLAT.LE.LATUL)GO TO 310
      SSLAT=LATLL
      SSLON=SSLON+DLON
310   IF(SSLON.LE.LONUL)GO TO 320
      GO TO 460
320   A=57.29578
      B=(LONSTA-SSLON)/A
      C=LATSTA/A
      D=SSLAT/A
      Z=COS(B)*COS(C)*COS(D)+SIN(C)*SIN(D)
      DIST=ACOS(Z)*40000*A/360
      R=SQRT(DIST**2+DEPTH**2+CO**2)
      IF(EQNTYP.EQ.1)GO TO 330
      IF(EQNTYP.EQ.2)GO TO 340
      IF(EQNTYP.EQ.3)GO TO 331
      IF(EQNTYP.EQ.4)GO TO 332
      IF(EQNTYP.EQ.5)GO TO 333
      IF(EQNTYP.EQ.6)GO TO 334
332   RML=(ALOG(Y)-ALOG(1.48)+0.425*ALOG(R+25))/0.282
      GO TO 350
330   RML=ALOG((R+25)**1.7*Y/32)
      GO TO 350
331   RML=(ALOG(Y)+1.0+0.96*ALOG(R)-0.07)/1.07
      GO TO 350
333   RML=ALOG(Y*(R**1.3)/0.0004)/2.3
      GO TO 350
334   RML=ALOG(Y*R/0.00018)/2.3
      GO TO 350
340   RML=1.25*ALOG(Y*(R+40)**2/5600)
350   IF(RML.GT.MMAX) GO TO 455
      P=10**(YINT-SLO*RML)
      P1=EXP(-RLAMB*EXP(-RML/UBAR))
      SS=SQRT((1.+((RML-RMO)/(RMB-RMO)))/MM)
      K=0
      DO 440 I=1,N
      IF(LAT(I).GE.(SSLAT-DLAT/2).AND.LAT(I).LT.(SSLAT+DLAT/2))GO TO 420
```

```
      GO TO 440
  420 IF(LON(I).GE.(SSLON-DLON/2).AND.LON(I).LT.(SSLON+DLON/2))GO TO 430
      GO TO 440
  430 K=K+1
      EQ(K)=REF(I)
  440 CONTINUE
      IF(K.EQ.0)GO TO 500
  500 Q=P*K/N
      Q1=1.-(1.-P1)*K/N
      Q2 = 1.-(1.-Q1)/EXP(SS*(-1.96))
      Q3=1.-(1.-Q1)/EXP(SS*1.96)
      Q4=P/PIXELS
      PROB=PROB+Q
      PROB1=PROB1*Q1
      PROB2=PROB2*Q2
      PROB3=PROB3*Q3
      PROB4=PROB4+Q4
  455 SSLAT=SSLAT+DLAT
      GO TO 300
  460 CONTINUE
      RP=1/PROB
      RP1=1./(1.-PROB1)
      RP2=1./(1.-PROB2)
      RP3=1./(1.-PROB3)
      RP4=1./PROB4
      WRITE(6,470)RP,Y
  470 FORMAT(//24H RETURN PERIOD IN YEARS=,F10.3,7H FOR Y=,F10.3
     +,50H BY AV NOS SQUARE ROOT WEIGHTED AND LOCAL ACTIVITY)
      WRITE(6,491)RP4
  491 FORMAT(//24H RETURN PERIOD IN YEARS=,F10.3,
     +52H BY AV NOS SQUARE ROOT WEIGHTED AND UNIFORM ACTIVITY)
      WRITE(6,480)RP1
  480 FORMAT(//24H RETURN PERIOD IN YEARS=,F10.3,18H BY MAX LIKELIHOOD)
      WRITE(6,490)RP2,RP3
  490 FORMAT(//54H THE UPPER : LOWER BOUNDARIES FOR 95% CONFIDENCE ARES-
     1,/2F10.3)
      Y=Y+DY
      IF(Y.GT.YMAX)GO TO 798
      GO TO 701
  798 CONTINUE
  799 CONTINUE
      END
```

APPENDIX F

ATTENUATION EQUATIONS

ATTENUATION EQUATIONS

ESTEVA 1973

$$v = \frac{32e^{M}}{(R+25)^{1.7}}$$

McGUIRE 1978 (Soil site)

$$\ln v = 1.07M - 1.0 - 0.96\ln R + 0.07$$

HASEGAWA, BASHAM AND BERRY (1981)

Western Canada

$$v = \frac{0.0004e^{2.3M}}{R}$$

Eastern Canada

$$v = \frac{0.0018e^{2.3M}}{R}$$

Where v = ground velocity in cm/sec.

M = Richter magnitude

R = hypocentral distance