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Volume II
Seismic Exposure Software Application
Final Report

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Development and Initial Application of Software for Seismic Exposure Evaluation

Prepared for

National Oceanic and Atmospheric Administration

May 1982

Woodward-Clyde Consultants
Three Embarcadero Center, Suite 700, San Francisco, CA941 11

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PREFACE

This is the final report and the second of two volumes of documentation of work completed by Woodward-Clyde Consultants for the National Oceanic and Atmospheric Administration (NOAA) under Contract NA-80-RAC-000-91. The first volume is a user manual. The computer programs described in the manual incorporate a semi-Markov model of large earthquake occurrence in the calculation of seismic exposure.

This volume documents initial application of the software package to the Gulf of Alaska study region. Figure 0 shows the study region for which seismic exposure calculations were made. Seismic inputs were developed by personnel of the Seismological Research Unit (SRU) of the Alaska Geophysical Institute; the Lament Dougherty Geophysical Institute; the University of Texas at Galveston; and the United States Geological Survey (USGS) at Menlo Park and Denver.

The seismic exposure maps are for maximum horizontal acceleration, maximum velocity, and pseudo-relative velocity at 5% damping and a period of 0.8 seconds. Contours have been mapped for each ground-motion parameter that has a 33% level of exceedance or an equivalent 100-year return period in a 40-year future time period of interest.

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DEVELOPMENT AND INITIAL
APPLICATION OF SOFTWARE FOR
VOLUME II - SEISMIC EXPOSURE EVALUATION

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The Development and Initial Application of Software for Seismic Exposure Evaluation project was sponsored by the Bureau of Land Management (BLM) through a contract with the National Oceanic and Atmospheric Administration (NOAA). Mr. Rodney Combellick was the NOAA Technical Manager for the Study. The support, encouragement, and guidance from Mr. Combellick is acknowledged. This study is a part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP). Representatives of several Seismological Research Units have participated in the project through their many suggestions and their development of seismic inputs for application of computer software to the Gulf of Alaska study region. These representatives are listed below:

Mr. Rodney Combellick Mr. Joseph Kravitz	National Oceanic and Atmospheric Admininstration
Dr. Hans Pulpan	University of Alaska, Geophysical Institute
Dr. Klaus Jacob	Lament-Dougherty Geophysical Institute
Dr. John Lahr	USGS, Menlo Park
Dr. Robert Page	USGS, Menlo Park
Dr. David Perkins	USGS, Denver

The above-named individuals attended two project workshops to review and discuss the methodology and to establish necessary seismic inputs for the first application of the software package. The participants also provided valuable comments and

discussion on the first draft of the user manual. The project team appreciates the participants' support and interest in the study.

The project team consisted of the following personnel from Woodward-Clyde Consultants:

I. M Idriss	Project Director
Ashok Patwardhan	Project Manager
George E. Brogan, Paul Guptil, Edd Clark	Geology
Tom Turcotte, John M. Hobgood, Barbara Bogaert, Linda Seekins	Seismology
Khosrow Sadigh	Earthquake Engineering
Ezio Alviti, Ram B. Kulkarni	Probability Analysis

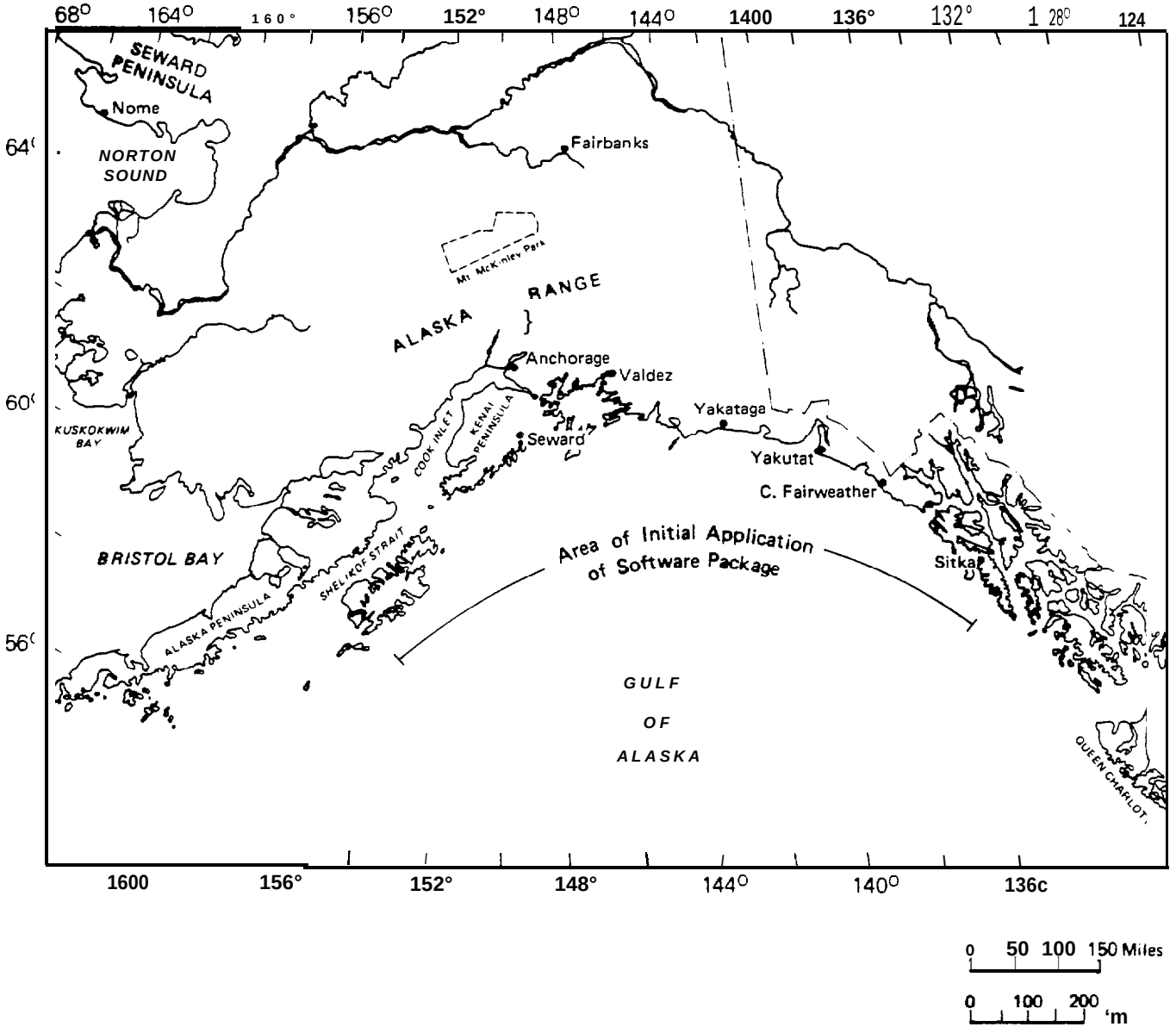


Fig. 0- Gulf of Alaska Study Area for the Initial Application of the SEISMIC. EXPOSURE Software Package to Generate a Seismic Exposure Map

VOLUME II

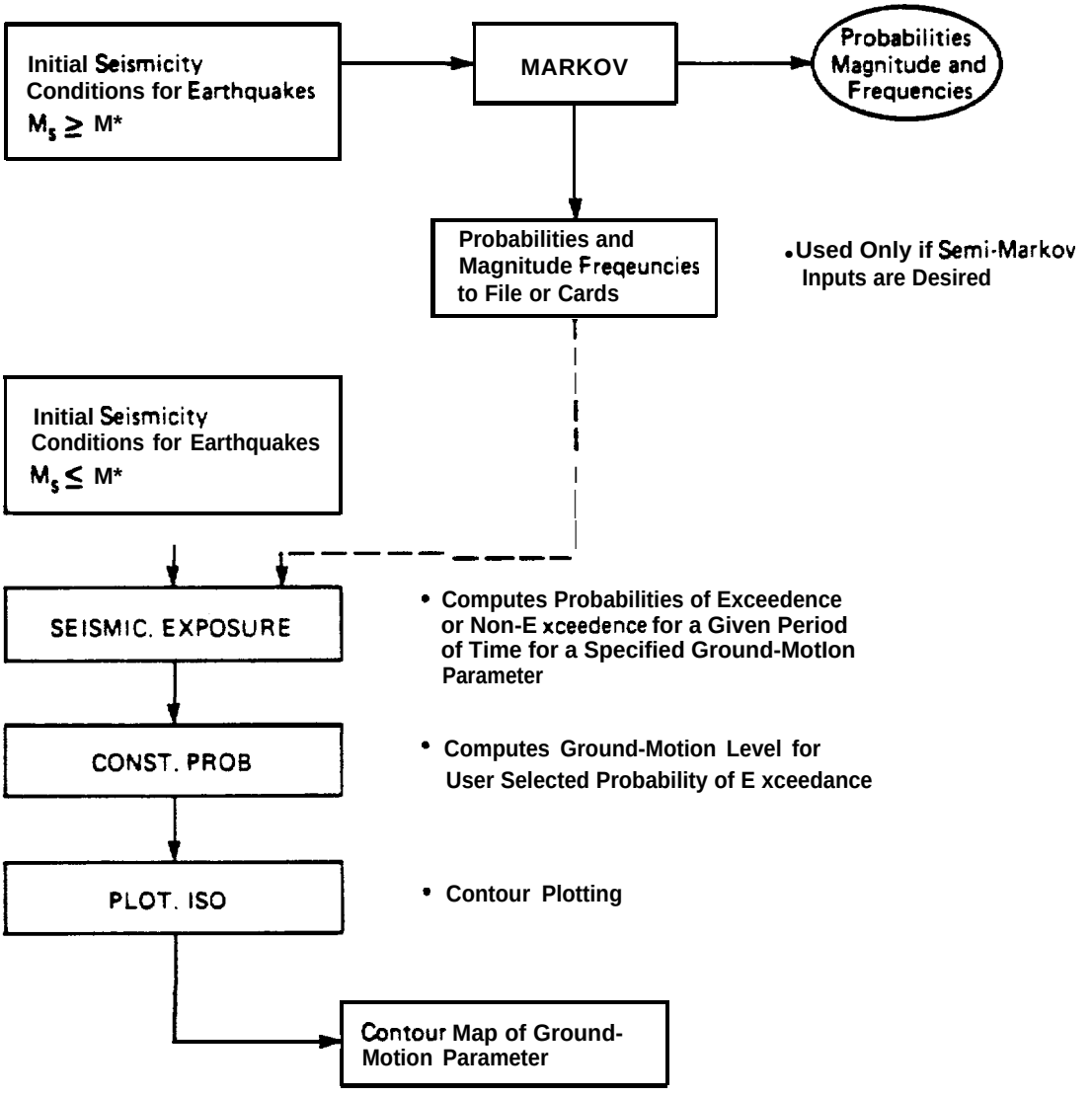
DEVELOPMENT AND INITIAL APPLICATION OF SOFTWARE FOR SEISMIC EXPOSURE EVALUATION

1.0 INTRODUCTION

This report presents the scope of activities and the methodology used by Woodward-Clyde Consultants (WCC) in the initial application of the seismic exposure software developed under NOAA Contract NA-80-RAC-000-91. The components of the software package computer program are shown schematically in Figure 1 and are collectively referred to as the SEISMIC.EXPOSURE software package. It consists of a main program called SEISMIC.EXPOSURE and three other programs: MARKOV, CONST.PROB, and PLOT.ISO. When the programs are used in conjunction with one another, they can generate seismic exposure maps for any tectonic environment.

The MARKOV program represents a new approach to characterizing the occurrence of large and great earthquakes by using a semi-MARKOV model. This model has a temporal and spatial memory of historical seismic activity that is used in modeling the probability of occurrence for projected future seismicity in subduction zone environments.

Two workshops were held in San Francisco by WCC for the Seismological Research Unit (SRU) participants. The purpose of the workshops was to review and evaluate the SEISMIC.EXPOSURE software as it was being developed and to develop initial application inputs. These inputs of source geometry and source seismicity for the Gulf of Alaska region were checked for consistency and accuracy before being implemented into computer code. Review comments on the first trial map for the Gulf of Alaska were solicited from NOAA and



M*- User Defined Magnitude Cut-Off e.g., $M_s = 7.8$

Fig. 1- Schematic of SEISMIC. EXPOSURE Software Program- The SEISMIC. EXPOSURE Program is the Main Program and can Accept Input from the semi-Markov simulation in the MAR KOV Program if the Option is Chosen. The Programs CONST. PROB and ISO are Sub-Programs of the Main Program SEISMIC. EXPOSURE.

from selected representatives of the SRU participants. An independent review board of consultants provided review and comment on the software development activities. Three seismic exposure maps were produced using the SRU inputs. The ground-motion parameters mapped are maximum horizontal acceleration, maximum velocity, and pseudo-relative velocity at 5% damping and 0.8 second period.

This report is organized into six sections. The following five sections provide a discussion of the methodology, data inputs, results, summary and conclusions, and suggestions for applications of the project results. When read in conjunction with Volume 1, this report provides a complete description of the computer algorithms used, the mathematical theory, and the application of the software package to seismic exposure evaluation.

2.0 METHODOLOGY

The software presented here was developed in compliance with: a) the scope of work proposed to NOAA; b) the recommendations from SRU participants during the two NOAA workshops in San Francisco; and c) the recommendations from the review board of consultants. In the first workshop, software developments to that date were discussed, and SRU participants were oriented to the inputs and the proposed algorithm software package. After the workshop, participants were sent copies of first drafts of the user manuals and of the suggested seismic inputs for their review and comment.

The second workshop was held so SRU participants could generate inputs for source geometry and source seismicity for the first application of the software package to the Gulf of Alaska data. Editorial changes for the two draft user manuals

were discussed with the participants, and two modifications were suggested for the SEISMIC.EXPOSURE program.

The inputs were checked for consistency, and modifications were made as required. A trial map for maximum horizontal acceleration was generated from these inputs. The seismic exposure map for 100-year-return-per iod accelerations in the Gulf of Alaska for a period of interest of 40 years was sent to NOAA and to several SRU participants for their review and comment. These comments were reviewed and discussed before implementation and before the seismic exposure maps and the user manual for the SEISMIC.EXPOSURE software package were generated.

3.0 DATA INPUT

3.1 Assessments of Inputs for the SEISMIC.EXPOSURE Program

The assessments of source geometry, source seismicity, fault-length/magnitude relationships, and attenuation relationships used in the initial application of the software were based on results obtained from the research efforts of the SRU participants. These inputs are summarized in the figures, tables, and appendices in this volume, and are discussed in the following four sections.

3.1.1 Earthquake Source Geometry

The SRU participants divided the earthquake sources into four categories which are shown in the two maps in Figures 2 and 3.

Sources along the subduction zone were typically described as being double dipping, from a 6-km to 40-km depth in the offshore area of the Alaska Peninsula, then dipping to a 125-km depth in the vicinity of the volcano line of the Aleutian

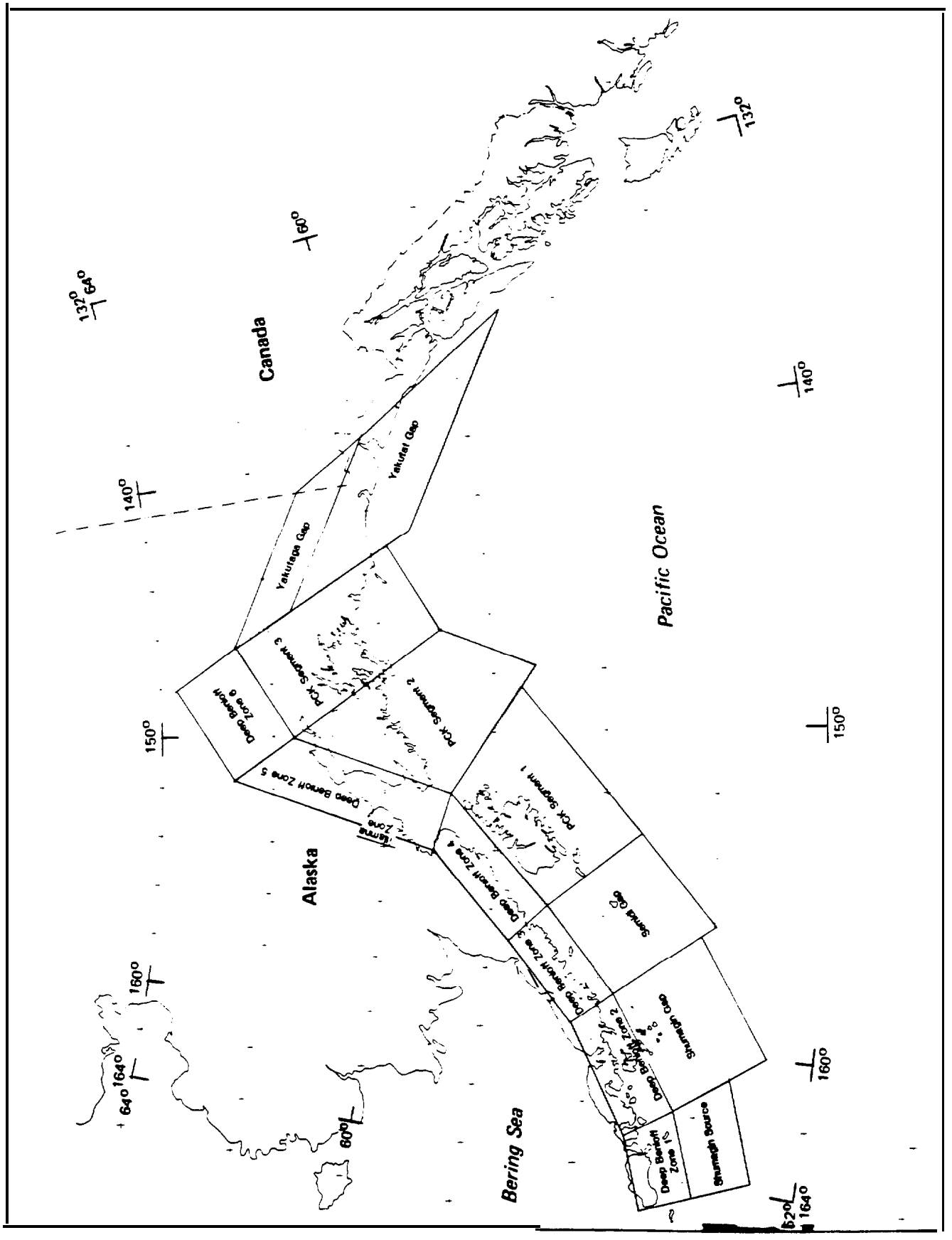


Fig. 2- Gulf of Alaska Thrust Benioff Zone

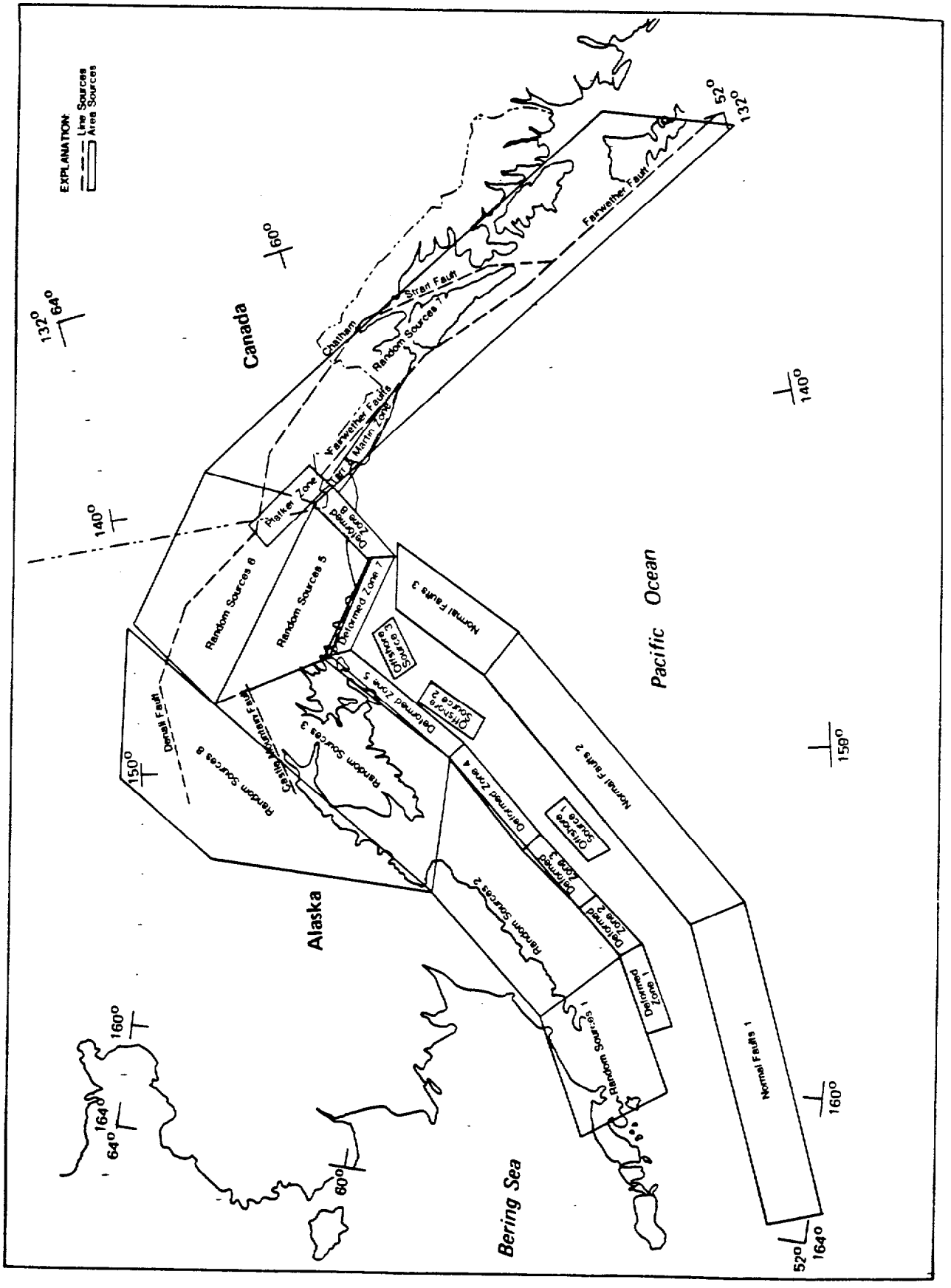


Fig. 3 - Gulf of Alaska Seismic Sources

Peninsula (see Figure 2). This configuration was chosen on the basis of work done by personnel of the University of Alaska Geophysical Institute (AGI) in the Kenai Peninsula area, and by personnel from the Lamont Geophysical Observatory of Columbia University in the Shumagin Islands region of the Alaska Peninsula. In the Yakutat-Yakataga area, personnel of the USGS provided knowledgeable guidance in establishing the configuration of earthquake sources in that region. Here the subduction zone was as shallow as 6 km, dipping first to 15 km and then to 40 km farther inland.

Normal faults, offshore faults, and the deformed zone were given orientations and spatial extents based upon adjustments to the OASES (1978) results. Random sources were selected to underlie the entire area of earthquake sources at a shallow depth in order to account for a background seismicity level not correlated with mapped geologic features. These sources are shown in Figure 3.

Earthquake source geometries for most onshore faulting have not been included in the analysis. The SRU participants felt that, for a regional seismic exposure application, these sources would not provide significant ground motions when compared to the selected earthquake sources. The only exceptions were the faults associated with the Fairweather-Denali fault system. Following the workshops, limitations in the program's ability to handle certain geometries were discovered (see Volume I). Slight modifications in some of the source geometries were necessary. The original source shapes were approximated as closely as the restrictions permitted. Source geometry information is summarized in Appendix A.

Maximum earthquakes were estimated by the SRU participants on the basis of the following: the M_w scale (Hanks and Kanamori,

1979; Kanamori, 1977), Wyss (1979), and the professional judgments of the SRU participants based on their knowledge and experience. These values are also presented in Tables A-7 through A-9.

3.1.2 Earthquake Recurrence

Assessments were made in two steps. First, earthquake recurrence estimates were established on sources for the magnitude range M_s 5.0 to 7.8. These assessments were established by use of adjustments to Gutenberg and Richter (1956) type magnitude-frequency relations. The magnitude-frequency relationships constituted a guide from which judgments were made by SRU participants about the modifications required for each distribution on the basis of their data and experience with the seismicity and tectonics in the respective geographical areas. These adjustments were subjective and were made after comparing and contrasting the levels of activity of local and regional earthquake sources in Alaska.

These estimates were checked by WCC personnel for consistency between regional seismicity levels. A summary of the SRU participant consensus on estimates of earthquake recurrence is shown in Table A-4. The magnitude-frequency relationships estimated from these recurrence characteristics are provided in Appendix A as Figures A-1 through A-9. The magnitude-frequency curves were broken into $\pm$ 0.5 magnitude increments. The number of earthquakes in each magnitude increment was calculated for a period for which the historical earthquake data were assumed to be complete (75 years). The resulting magnitude distributions for each earthquake source were entered into the SEISMIC.EXPOSURE program with the appropriate source geometries and are shown in Table A-5.

Step 2 consisted of estimating the recurrence for earthquakes greater than M_S 7.8 occurring in a seismic gap along the subduction zone in the Gulf of Alaska. A new feature of this software package is that these estimates can be made on the basis of a semi-Markov modeling of the seismic gap seismicity environment. A detailed discussion of the assessment process for these inputs is given in Section 3.2 of this report. Details of the semi-Markov mathematical theory and program can be obtained by referring to Volume I, Sections 4 and B.2. The recurrence information (probabilities of occurrence) for seismic gaps (for earthquakes of magnitude greater than Ms 7.55) required by the SEISMIC.EXPOSURE program was generated by first executing the MARKOV program for appropriate semi-Markov inputs.

3.1.3 Fault Rupture-Length/Magnitude Relationship

Because of the occurrence of large earthquakes in the Gulf of Alaska region, it was suggested by the SRU participants that a fault rupture-length/magnitude relationship should be used which reflected the characteristics of earthquakes with large rupture areas. The relationship that was chosen is based upon the Wyss (1979) relationship between earthquake magnitude and fault-rupture area. There is an implicit assumption that fault down-dip width of rupture along the subduction zone has a maximum of about 200 km while the length of the rupture can be 1,100 km. The relationship used is shown below:

$$M_S = \log A + 4.15$$

where A is the area of the fault rupture plane in (km^2).

For the purpose of determining the rupture dimensions for a given magnitude, M_S was assumed to be equivalent to M_w. Figure 4 shows a listing of earthquake magnitude, source area,

$M_s = \log A + 4.15$

$M_s \approx M_w$	A	L	W
5.5	22.4	4.7	4.7
6.0	70,8	8.4	8.4
6.5	224	15	15
7.0	708	27	27
7.5	224o	47	47
8.0	7080	90	80
8.5	22400	180	175
9.0	70800	400	175
9.5	224000	1100	200

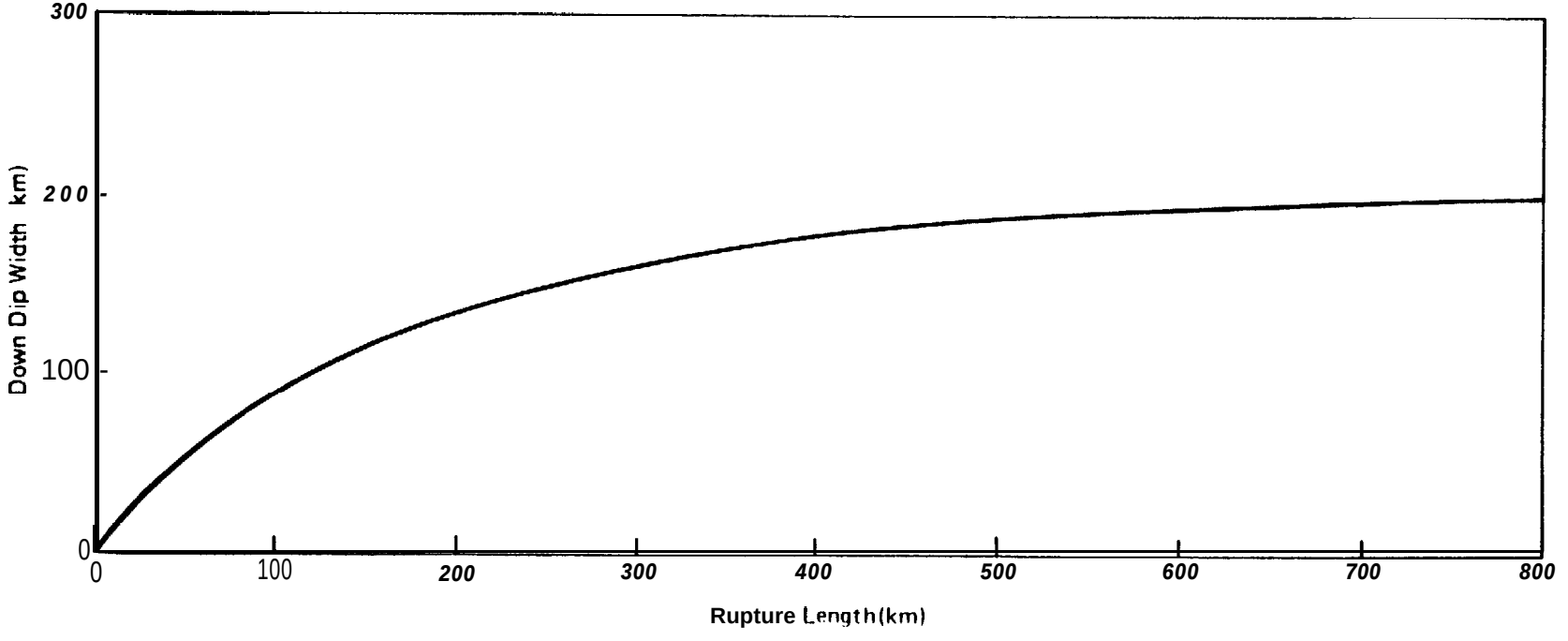


Fig. 4- Approximate Fault Rupture Length Magnitude Relationship Based on Wyss (1979).

length of rupture, down-dip rupture width, and the relation between the rupture width and length for which the tabulated values were estimated. Complications arose when several of the faults were assigned earthquakes with rupture dimensions that were too large to fit on the fault surface. Therefore, it was necessary to scale down the rupture length and widths for magnitudes $\geq$ 8.0. (Test runs were made comparing the results of reduced rupture size against lower magnitude cutoffs on the smaller faults. Reauction of the rupture size proved to be the more conservative option). The rupture dimensions used are shown in Appendix A, Table A-3.

3.1.4 Attenuation Relationships

The consensus of the SRU participants was that subduction zone earthquakes have source-site paths that are different from crustal earthquakes. Although the affect on maximum ground-motion values can also in part or entirely be explained by source effects, it was felt that data were insufficient for the Alaska subduction zone environment to attribute the attenuation differences to specific source effects; hence, the observational differences in source-path effects were kept in the analysis. Consequently, the participants felt that the attenuation relationships (WCC, 1978) for transmission for Source Type A and transmission for Source Type B, valid for distances of less than 20 km and greater than or equal to 20 km, respectively, were an appropriate start for selecting modified relationships for this study. The revised relationships are valid for Benioff zone sources as shallow as 6 km in depth (closest distance to a site), and these relationships would not have a discontinuity at 20 km in depth. Because the non-subduction zone sources were less than 6 km in depth, the relationships for ground-motion parameters with Source Type A curves did not change. On the other hand, the Source Type B curve for maximum acceleration was modified since it changed

more dramatically as a function of distance than the other parameters (e.g., displacement and pseudo-relative velocity). The attenuation relationship for maximum acceleration for Source Type A, stiff sites, is summarized below:

$$A_{max}\ (\text{median}) = 191 \exp(0.823\ M_S{}^*) \times (R+C)^{-1.56}$$

in which Amax is the maximum acceleration (in cm/sec^2), R is the closest distance to rupture surface (in km), and C is the distance-normalizing parameter which is magnitude-dependent, as follows:

$$C = 0.864 \exp(0.463\ Ms)$$

The plot of median attenuation relationships for Source Type A, stiff sites, is presented in Figure 5.

The attenuation relationships for Source Type B for OASES (1978) were developed by regression of applicable data predominantly clustered in the distance range 60 to 150 km. In the OASES study, a reasonable fit to the data was obtained by conducting regression analyses with pre-selected slope coefficients. The slope coefficient which was finally selected for maximum acceleration was -1.05. The resulting attenuation relationship** was considered to provide reasonable estimates of peak acceleration for transmission Source Type B for distances greater than 20 km.

For the present study, the Source Type B relationships are required by the SRU participants to be applicable to distances as close as 6 km. Due to this condition imposed by the SRU

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*or M_w

**A_{max} (median) = 284 exp (0.587 Ms) x $(R+C)^{-1.05}$

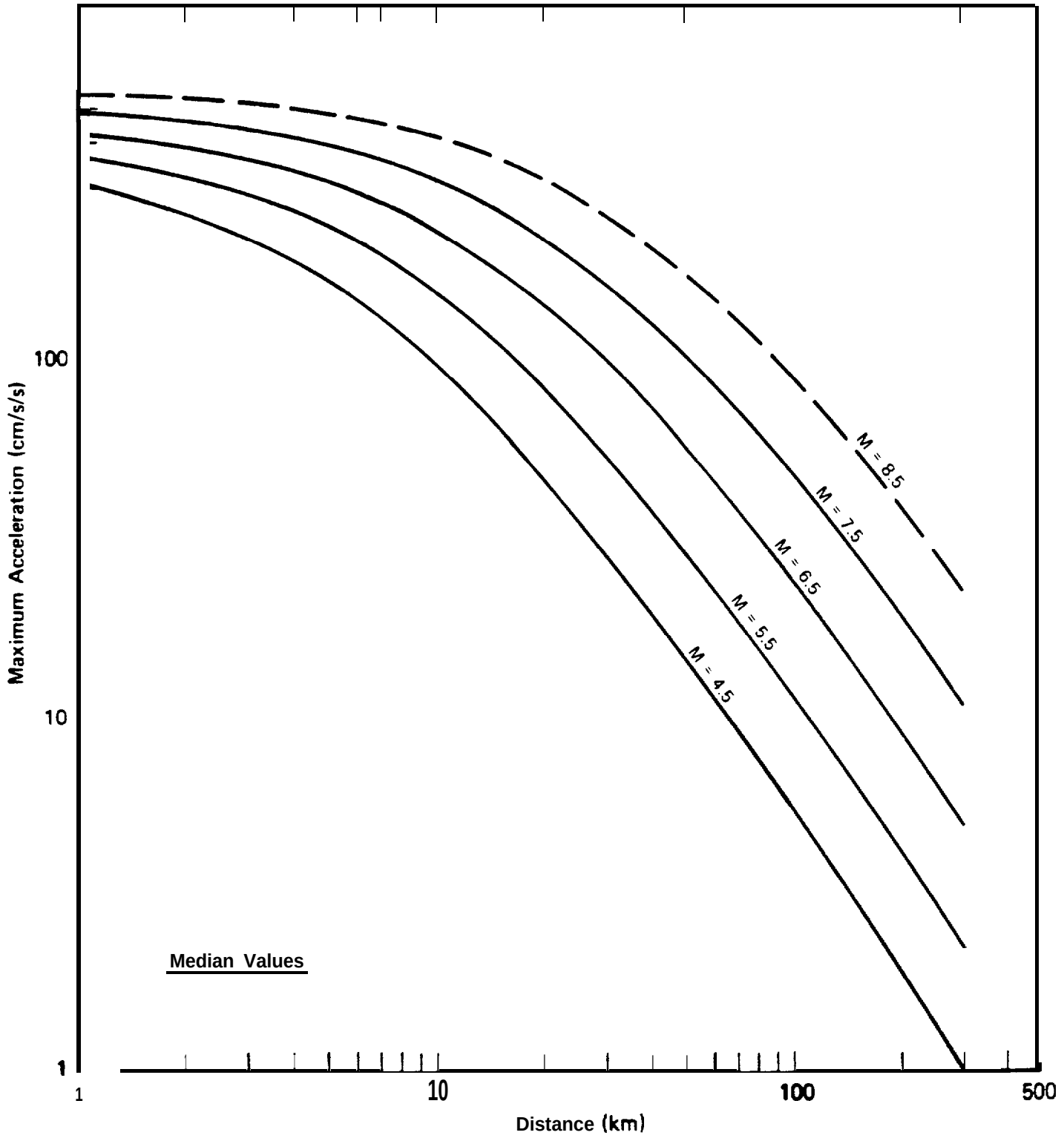


Fig. 5- Attenuation Relationship for Maximum Acceleration For Source Type A - Stiff Sites

participants, reasonable extrapolations to such close distances were permitted by modifying the Source Type B attenuation relationship for maximum acceleration. The revised relationship is as follows:

$$A_{max}\ (\text{median}) = 210 \exp(0.5\ Ms) \times (R+C)^{-0.85}$$

The plot of the selected relationship is shown in Figure 6.

Comparisons of attenuation relationships for transmission for Source Types A and B are shown in Figures 7 and 8 for magnitudes 6.5 and 7.5, respectively. The following are two major constraints which were taken into consideration while deriving the revised relationships in this study for transmission Path B:

(1) In the distance range where the Source Type B data are predominantly clustered (60 to 150 km), the revised attenuation relationship predicts essentially the same maximum accelerations as the relationship for Source Type B given in the WCC (1978) report.

(2) The various coefficients for the revised relationship for Source Type B were selected such that at exceptionally close distances, the predicted accelerations are essentially the same as those predicted for the Source Type A relationship, as can be readily seen in Figures 7 and 8. Consequently, at distances smaller than about 40 km, and particularly at distances closer than 20 km, the revised relationship predicts significantly lower maximum accelerations than the WCC (1978) Source Type B relationship.

The Source Type A and the selected Source Type B attenuation relationships were used for maximum horizontal acceleration in

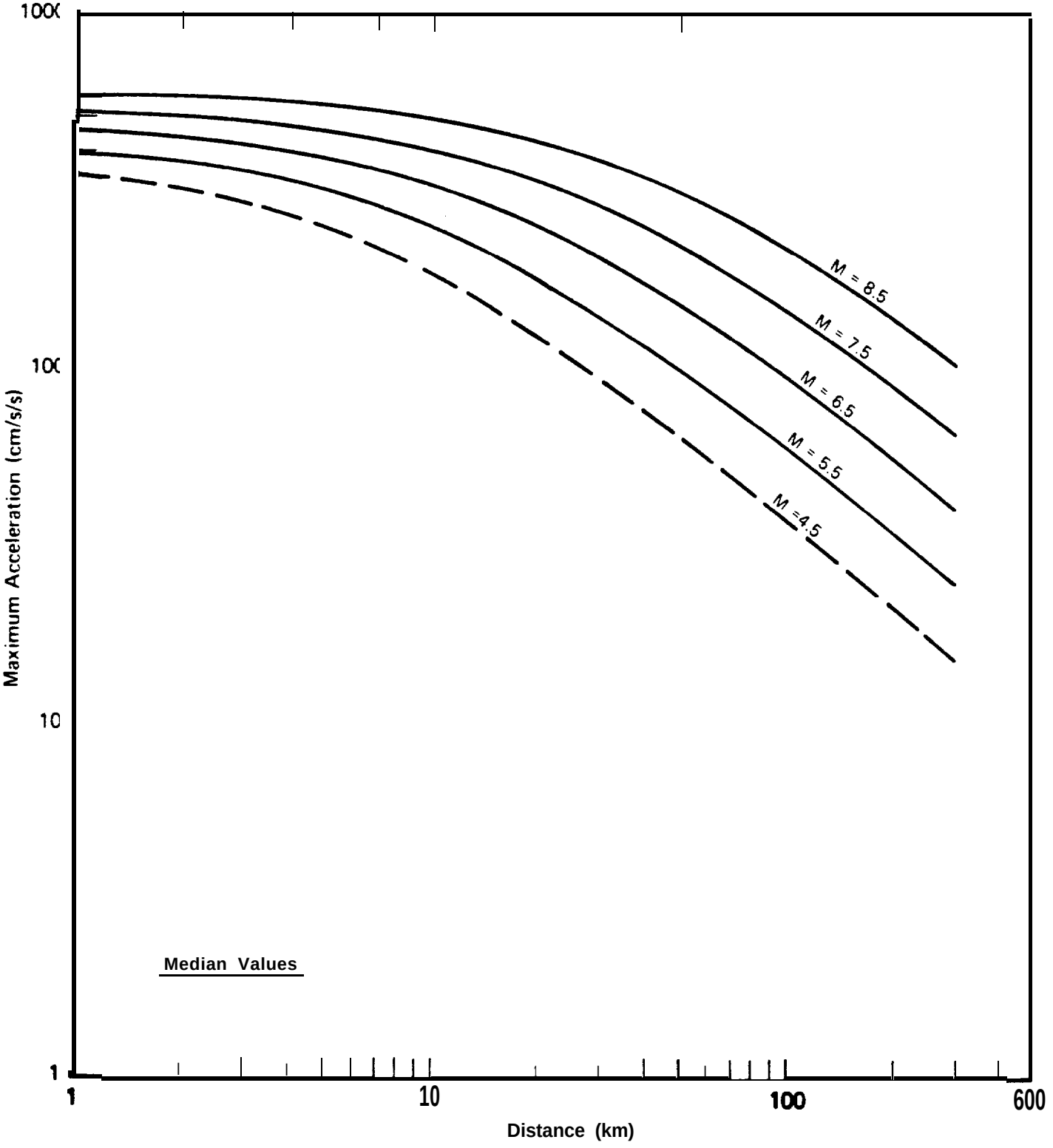


Fig. 6- Selected Attenuation Relationship for Maximum Acceleration For Source Type B - Stiff Sites

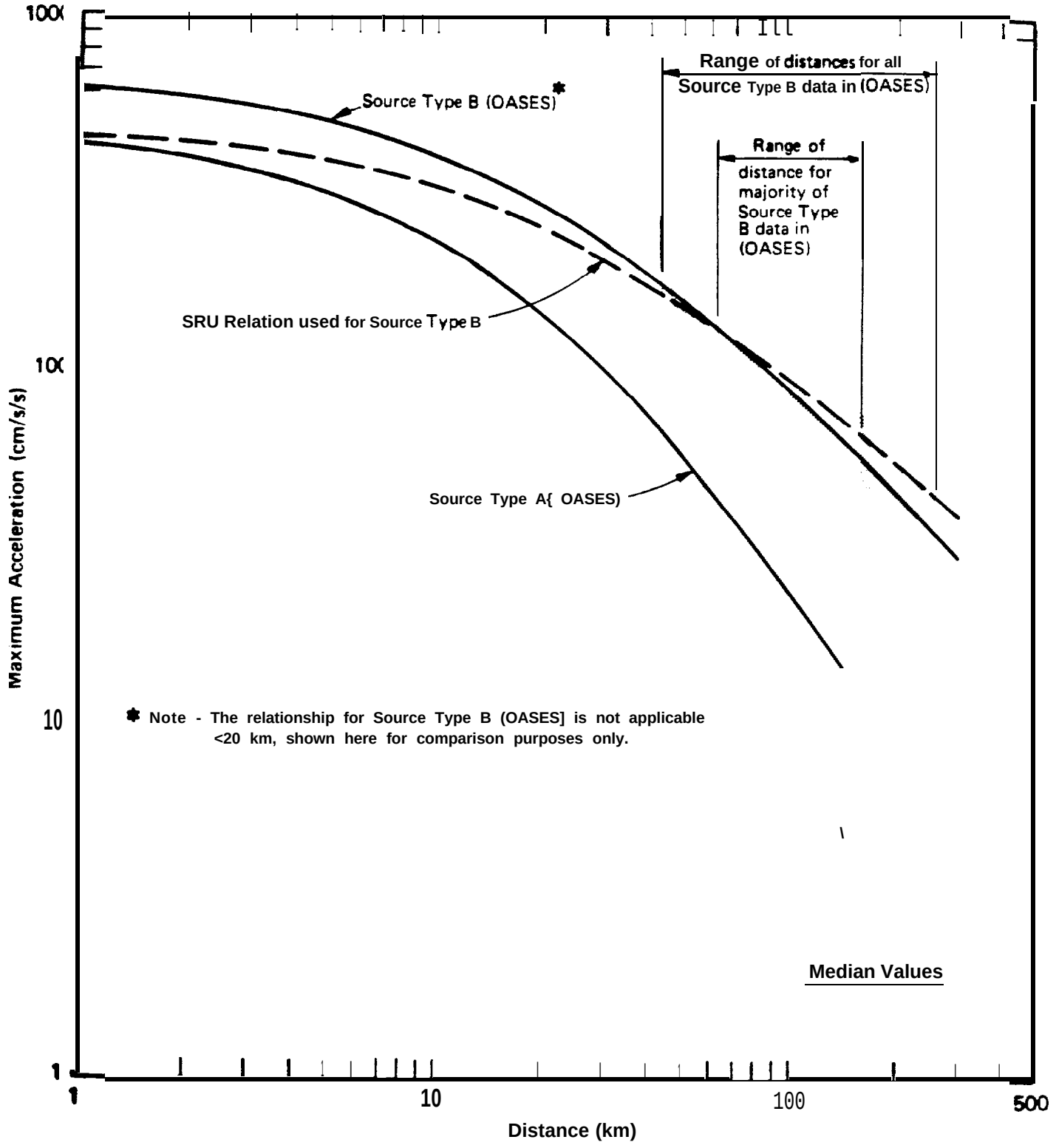


Fig. 7- Comparison of Attenuation Relationships for Maximum Acceleration for Source Types A and B Magnitude 6.5- Stiff Sites

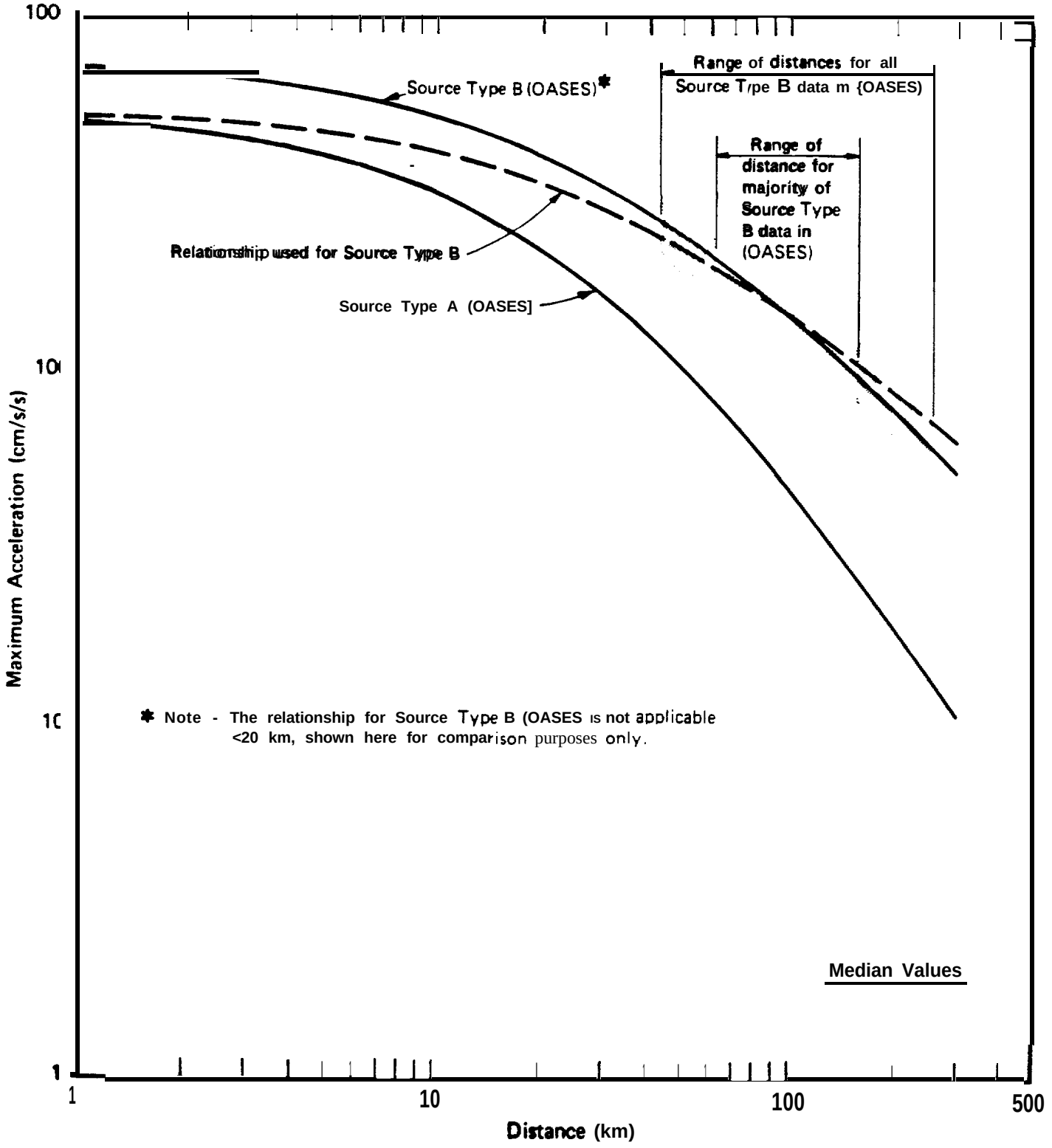


Fig. 8- Comparison of Attenuation Relationships for Maximum Acceleration Source Types A and B Magnitude 7.5- Stiff Sites

the generation of the seismic exposure maps in Section 4. Parameters for other ground-motion variables for the remaining seismic exposure maps were taken from the WCC (1978) result; the parameters are given in Table 10.

3.2 Assessment of Inputs for the MARKOV Program

The assessment of inputs for the semi-Markov model in the program MARKOV was completed in the following steps:

1. Selecting zones for applying the semi-Markov model.
2. Defining states and unit time.
3. Assessing transition probabilities, P_{ij}.
4. Assessing probability distributions of holding times, $t_{ij}(m)$.
5. Compiling available historical seismicity data for each of the selected zones.
6. Defining initial seismicity conditions for each zone.

A detailed discussion is given in Appendix C of how subjective probability analysis techniques are used in making the Bayesian analysis in the semi-Markov modeling. These assessments were made during group meetings held as part of the second SRU workshop in which expert geologists and seismologists from the various research units participated. The values reported in this section reflect the group consensus values used by WCC in producing the initial application seismic exposure maps.

3.2.1 Selection of Zones for Applying the Semi-Markov Model

Zones were selected primarily on the basis of their correspondence to recognized seismic gaps, each of which have been historically observed to rupture about the areas selected. The selected zones were (see Figure 9):

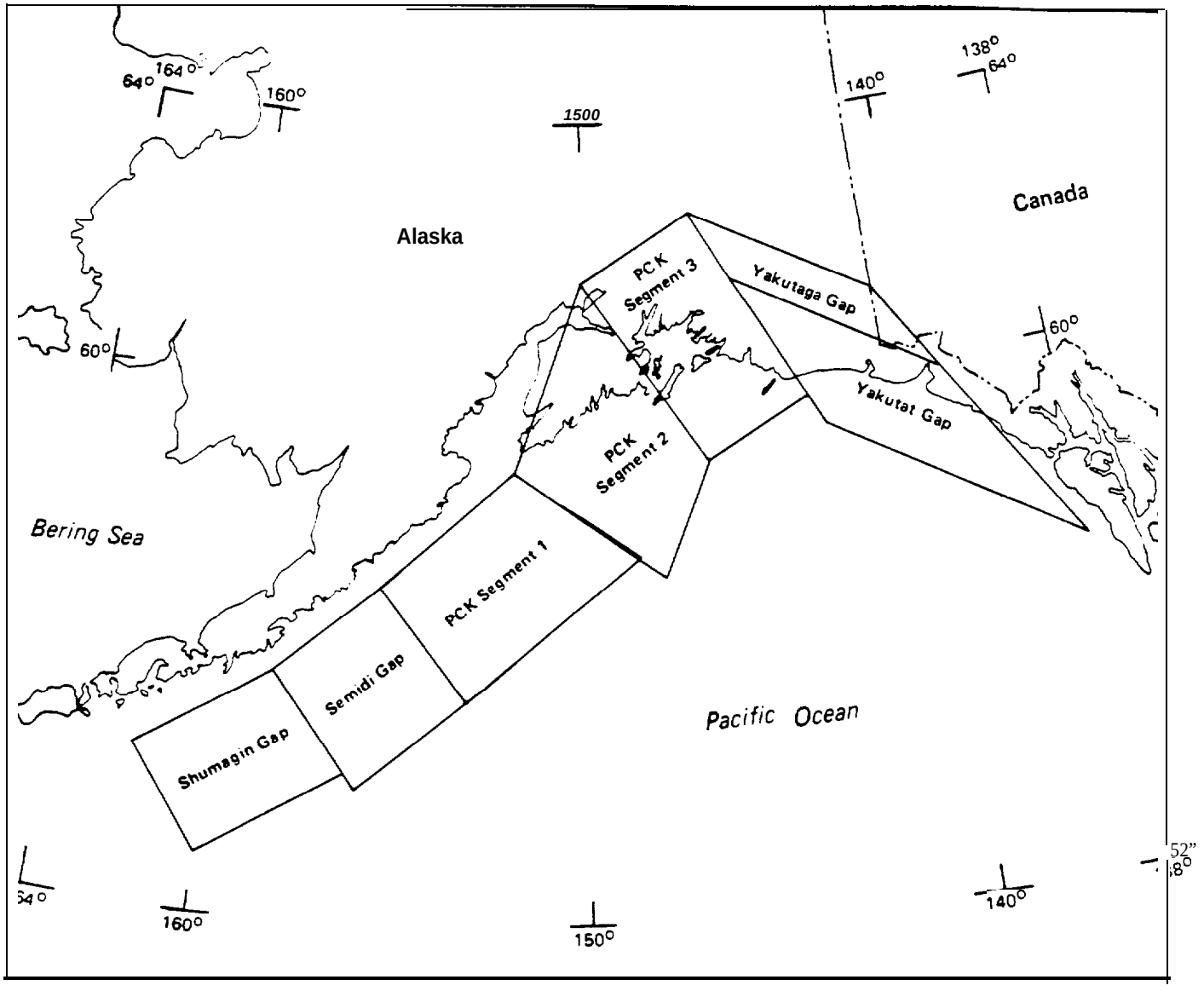


Fig. 9- Gulf of Alaska Semi-Markov Zones

Yakutat Block

Yakataga Gap

PCK Gap (consisting of three sections: Prince William Sound, Cook Inlet, and Kodiak)

Semidi Gap (1938 earthquake rupture zone)

Shumagin Gap

3.2.2 Definition of States and Unit Time

The discrete magnitude states were defined in terms of the 100-second surface magnitude or M_w (Kanamori, 1977; Hanks and Kanamori, 1979). This measure of the size of large and great earthquakes does not saturate as Ms does at magnitude 8 Ms levels and greater. Hence, whenever available, M_w magnitudes were used in the magnitude specifications for historical seismicity greater than or equal to M_s 7.55. These states are defined in Table 1.

A unit time interval of five years was considered reasonable by judging that the likelihood was negligible for more than one large earthquake (Ms $\geq$ 7.8) to occur within five years in any one zone over the next 40 years.

3.2.3 Assessment of Transition Probabilities, p_{ij}

A transition probability p_{ij} is the likelihood that the state of the next large earthquake will be j, given an earthquake in state i at the present time. To obtain p_{ij}, a continuous probability distribution on M_i was assessed. By discretizing the continuous distribution into intervals defined by the states, one can calculate p_{ij}. This calculation is performed within the computer program MARKOV. The necessary inputs to MARKOV include the four fractiles (0.25, 0.50, 0.75, and 1.0) of M_i for each i.

TABLE 1
DISCRETE STATES FOR THE SEMI-MARKOV MODEL

State Index	Magnitude Range (M_s or M_w)	Representative Value
1	7.8 - 8.29	8.05
2	8.3 - 8.79	8.55
3	8.8 - 9.29	9.05

TABLE 2
FRACTILES OF M_I (M_S or M_w)

Reference Case - The same fractiles for all zones.

State Index, i	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
1, 2, or 3	8.3	8.5	8.7	9.3

Parametric Case - Different fractiles for the following zones might be used.

Zone	State Index, i	0.25 Fractile	0.50 Fractile	0.75 Fractile	I.O Fractile
PW or CI	1, 2, or 3	8.4	8.7	9.0	9.3
Yakataga Gap	1, 2, or 3	8.1	8.3	8.5	9.3

The fractiles of Mi were subjectively assessed using the procedures described in the Volume I user manual. The same fractiles were judged to be applicable to all zones. Table 2 shows the assessed fractiles.

As indicated in this table, the fractiles of Mi were judged to be independent of i; that is, the likelihood that the next large earthquake will be of a particular magnitude is the same regardless of the magnitude of the last large earthquake. One of the experts, however, considered it appropriate to vary transition probabilities for some of the zones. His assessments are also shown in Table 2 and can be used in parametric analysis.

3.2.4 Assessment of Probability Distributions of Holding Times, $t_{ij}(m)$

The program MARKOV requires the four fractiles of $t_{ij}(m)$ (0.25, 0.50, 0.75, and 1.0) for each i and j within each zone. The assessment of these fractiles closely follows the procedure described in Appendix C.

Experts generally agreed that the holding time between successive earthquakes of magnitude Mi and Mj was much more dependent on M_i (the magnitude of the last large earthquake) than on Mj (magnitude of the next large earthquake). This judgment was primarily based on the seismicity model proposed by Ando (1975) with which the experts were in agreement.

Because the experts felt more confident about providing subjective judgments for Shumagin Gap, the distribution of holding times was first assessed for this area. Distributions of holding times for other zones were assessed relative to the distribution assessed for Shumagin Gap. In fact, it was

considered reasonable to represent the holding times for a zone by applying a simple shift factor to the corresponding holding times for Shumagin Gap. Following the model by Sykes and Quittmeyer (1980) , the shift factor for a zone was assumed to be the ratio of width of a zone to the width of Shumagin Gap (see Figure 2).

Table 3 shows the fractiles of $t_{ij}(m)$ for the Shumagin Gap (Part 1); Table 4 shows the shift factors for other zones. The $t_{ij}(m)$'s for the other zones are presented in Appendix B.

3.2.5 Compilation of Historical Seismicity Data

The dates and magnitudes of large earthquakes that occurred in the Gulf of Alaska region were tabulated by using available records of historical seismicity, as shown in Table 5. The information in Table 5 was further analyzed to obtain all the instances in which an earthquake of magnitude M_j followed an earthquake of magnitude Mi in each of the defined zones. The data on transitions of earthquake magnitudes for each zone are shown in Table 6, while the data on holding times between Mi and Mj are summarized in Table 7.

3.2.6 Definition of Initial Seismicity Conditions of Each Zone

The magnitude of the last large earthquake (M_o) in a zone and the time elapsed since its occurrence (to) define the initial seismicity conditions of the zone. The data in Table 5 were used to estimate M. and to for each of the selected zones. Table 8 summarizes these initial conditions for several zones in addition to those five zones used in the analysis. The date of the last large earthquake occurring in the Yakutat Block and Shumagin Gap area is not precisely known. The parameter "t_o" was estimated to be anywhere between 200 to

TABLE 3
DISTRIBUTION OF HOLDING TIMES FOR SHUMAGIN GAP

	Holding Time (Years)			
	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	50	75	100	280
t_{12}	55	80	110	300
t_{13}	60	85	120	320
t_{21}	80	115	155	410
$'_{22}$	87	125	165	440
t_{23}	94	135	175	470
$'_{31}$	110	150	180	480
t_{32}	120	160	200	500
$'_{33}$	130	170	220	520

TABLE 4
SHIFT FACTORS FOR HOLDING TIMES OF GIVEN ZONES

Reference Zone: Shumagin Gap

Zone			Shift Factor
Yakataga Gap			0.37
Yakutat Block			0.75
PCK Gap			
	Pw	Segment 1	1.15
	CI	Segment 2	1.43
	K	Segment 3	1.75
Semidi Gap (1938)			1.15

TABLE 5

LIST OF ALASKA EARTHQUAKES SINCE 1788
WITHIN THE GULF OF ALASKA REGION

Date	LON,W[b]	M_w	State	Participating Source Regions	
1788, July 22	161.5 - 152.5(?)	(9.0) [c]	3	SHU 100%; SEM 100%; PCK.1 100%	
1788, August 7	163.0 - 160.5(b)	8.0 [c]	1	UNI_{east} 50%; SHU_{west} 40%	
1844, April 20	154.5	7.8	1	PCK.1	
1847, April 16	160.5 - 156.5(?)	8.5	2	SHU_{east} 50%; SEM_{west} 80%	
1848, June 30	156.5	7.8	1	SEM	
1880, September 28	156.5	½7.8	1	SEM	
1899, July 14	166.5 - 160.0	(7.8)	1	SHU or SEM (UNI or UNA)	
1899, September 4	145.5 - 142[d,e]	8.2(f)	1	YAK_G 50%; PCK.3 50%	
1899, September 10	142 ± 3(g)	(7.8)	1	YAK_G ?	
1899, September 10	142 - 138[d,e]	8.2(f)	1	YAK_G 50%; YAK_T 50%	
1900, October 9	153[d,e]	8.1[f]	1	PCK.1 100%	Intensities drop below VIII to east, no reports to west.
1902, January 1	165 ± 9[g]	(7.8)	1	UNA ?	No felt reports(g) .
1903, June 2	156[g] ± ?	8.3[h]	(2) (i)	(SEM and/or PCK.1) (i)	Not shallow, probably intermediate depth[g]; felt at Valdez[j].
1938, November 10	159 - 156[k]	8.2	1	SEM 100%	
1946, April 1	164.5 -O 162(k)	7.8	1	UNI 100%	

TABLE 5 (continued)

Date	LON,W[b]	M_w	State	Participating Source Regions	
1957, March 9	180 - 167 or 164.5	9.1	(3) (1)	(UNA 100%)	Probably did not rupture UNA
1958, July 9	140 - 137	8.2	1	FAIR	Consider removing from list purposes of computing Pij
1964, March 27	152 - 146.5	9.2	3	PCK.1,2,3	
and					h_{ij} for areal sources.
1972, July 30	137 - 135	(7.8)	1	SIT	

Footnotes:

(a) Defined for sources normal to lines defined by the following modes: 74, 75, 80, 85, 86, 90, 95, 93, and 99, 98, 103.

(b) Estimate based on felt reports.

(c) () consensus of operators; estimate by LDGO-group.

(d) With respect to segment 99-98-103.

(e) Limit of I_{MM} ½ VIII; approximately the rupture zone.

(f) Thatcher and Plafker (1977).

(9) Gutenburg (1956), instrumental epicenter, not based on felt reports.

(h) Richter (1958), p. 714.

(i) Only if shallow, which it probably is not. Suggest removing from list.

(j) Tarr and Martin (1912).

(k) Sykes (1971), aftershock area.

(1) House (1981) , probably did not rupture Unalaska zone, recommend removal from list.

TABLE 6
DATA ON TRANSITIONS OF LARGE EARTHQUAKE MAGNITUDES
FOR THE STUDY AREA

Magnitude of Last Large Earthquake	Magnitude of Following Large Earthquake
7.8 - 8.29	**7.8, 7.9, 8.2, 7.8, 9.2, 8.1**
8.3 - 8.79	**8.4, 8.3, 9.1, 8.4**
8.8 - 9.29	**8.2, 8.7**

TABLE 7
DATA ON HOLDING TIMES BETWEEN OCCURRENCES OF
LARGE EARTHQUAKES IN THE STUDY AREA

Magnitude of Last Large Earthquake	Magnitude of Following Large Earthquake	Holding Time (Years)
7.8 - 8.29	7.8 - 8.29	2,3,1,1
	8.3 - 8.79	31
	8.8 - 9.29	6
8.3 - 8.79	7.8 - 8.29	1,1
	8.3 - 8.79	1
	8.8 - 9.29	19
8.8 - 9.29	7.8 - 8.29	1,1
	8.3 - 8.79	
	8.8 - 9.29	

TABLE 8

INITIAL CONDITIONS FOR THE SEISMOGENIC REGIONS OF THE GULF OF ALASKA
PARTIAL INPUT FOR THE MARKOV PROGRAM

Range Name	Range Code	Range Longitude(W)	Date	Magnitude M_w	Magnitude i	Elapsed Time (Years to 1 July 1981)
Unalaska*	UNA	167.0-164.5	1957, March 9	9.1	3	24.31
or			1902, January 1	(7.8)	1	79.50*
or			1899, July 14	(7.8)	1	81.96
or			¼ 1845	(9.0)	(3)	½136. *
Unimak*	UNI	164.5-161.9	1946, April 1	(7.8)	1	35.25
Shumagin	SHU	161.9-158.9	1903, June 2	8.3	2	78.08
or			1899, July 14	(7.8)	1	81.96*
or			1847, April 16	(8.5)	(2)	134.21*
Semidi	SEM	158.9-155.8	1938, November 10	8.2	1	42.64
Kodiak	PCK-1	155.8-152.1	1964, March 27	9.2	3	17.26
Cook Inlet	PCK-2	152.1-150.1	1964, March 27	9.2	3	17.26
Prince William Sound	PCK-3	150.1-146.5	1964, March 27	9.2	3	17.26
Yakataga	YAG	144.4-139.8	1899, September 4, 10	8.3	1	81.81
Yakutat	YAT	139.8-136.0	¼ 1850	(8.0)	1	131
Fairweather	FAIR	140 -147	1958, July 9	8.2	1	22.98
Sitka*	SIT	137 -135	1972, July 30	(7.8)	1	8.92

* These zones were not used in the initial seismic exposure application.

TABLE 9

EXPECTED NUMBER OF EVENTS FROM THE SEMI-MARKOV MODEL

Source I.D.	Expected Number of Events of Given Magnitude $E\ R_{mo_1}$ $M_1 = 8.05$	$M_2 = 8.55$	$M_3 = 9.05$	Total Expected Number of Events for the Given Source $E\ R$
Shumagin Gap	0.196	0.084	0.024	0.304
Semidi	0.287	0.126	0.032	0.445
PCK Segment 1	0.10	0.035	0.008	0.143
PCK Segment 2	0.091	0.022	0.005	0.118
PCK Segment 3	0.084	0.015	0.004	0.103
Yakataga Gap	0.14	0.157	0.058	0.355
Yakutat Block	0.014	0.018	0.003	0.035

Total number of expected events from all sources = 1.5

ERRATA

DEVELOPMENT AND INITIAL APPLICATION OF SOFTWARE FOR SEISMIC EXPOSURE EVALUATION

VOLUME II: SEISMIC EXPOSURE SOFTWARE APPLICATION

In Figure 0 the area of initial application of the software package is inaccurate. Exact locations of the seismic sources are shown in Figures 2 and 3. The area for which ground motion values were computed is shown in Figures 10, 11 and 12.

p. 5 "Tables A-7 through A-9" should be "Table A-4"

p. 11 "Yakutat Block" should be "Yakutat Gap"

1,500 years for the Yakutat Block and to be 80 to 133 years for the Shumagin Gap. In both cases, the expected value of to was used in the analysis. The result of varying to from its expected value may be examined in sensitivity analyses.

It should be noted that, since a discrete-state and discrete-time model is used, it is important only to know to which interval of magnitude (or time) the last earthquake belonged.

Changes in M. (or to) that do not change the interval have no effect on the results.

3.2.7 Comments on Assessment of Subjective Data

The SRU participants in the group assessment meetings believed that the subjectively assessed data could vary significantly, depending upon which experts were interviewed. The variations in the assessed values of earthquake magnitude can be $\pm$ 0.3 units, and those in the assessed holding times can vary by a factor of 2 (i.e., multiplied or divided by 2). A reasonable way to investigate such variation is through sensitivity analysis. It should be noted that, as the amount of objective data (historical seismicity data) increases, the influence of the subjective opinions on the final results decreases. Thus, the question of which expert judgment to use in the analysis may not be important when such judgments are combined with a significant amount of objective data.

3.3 Summary of Data Inputs

Seismic exposure inputs for the MARKOV program, as developed during the SRU participant's workshop, were checked and implemented. The program was executed and the output was used as a part of the input to the SEISMIC.EXPOSURE program. Because of geometry considerations, the Shumagin Gap was subdivided into

three zones in the semi -Markov analysis. The output from the SEISMIC.EXPOSURE program consisted of probabilities of occurrence of various numbers of earthquakes occurring in states 1, 2 or 3 for each of the defined zones of the subduction zone bordering the Gulf of Alaska. The input data for the MARKOV program and the program output is shown in Tables B-1 through B-5 and Figure B-1 of Appendix B. This program output was then used as a part of the input data to the SFISMIC.EXPOSURE program.

4.0 INITIAL APPLICATION RESULTS--KEY FEATURES

The SEISMIC.EXPOSURE program generated probabilities of exceedance for three parameters: maximum horizontal acceleration, maximum horizontal velocity, and maximum pseudo-relative velocity at 0.8 second period, and damping of 5%. The level of exceedance probabilities were for the time period 1981 through 2221 and for the 33% level or the equivalent 100-year return period values. These were selected at 96 grid points in the Gulf of Alaska study area. These inputs were used by the CONST.PROB and PLOT.ISO programs in order to obtain seismic exposure maps. These program inputs and outputs are summarized in Appendix B, and the seismic exposure maps are discussed in the following section.

Results of the seismic exposure analysis for all three maps are presented in Figures 10 through 12 and show high-relief areas in the areas of seismic gaps in the Shumagin Islands, Semidi, Yakataga and the Yakutat areas. These areas of relatively high ground motion values are due to several effects. These effects will be discussed after important features of the seismic exposure modeling are discussed below.

First, the source seismicity not only is described for earthquakes of Ms < 7.8, but also for large magnitude earthquakes

Fig. 10- Acceleration (cm/sec^2)
Probability of Non-exceedence .667

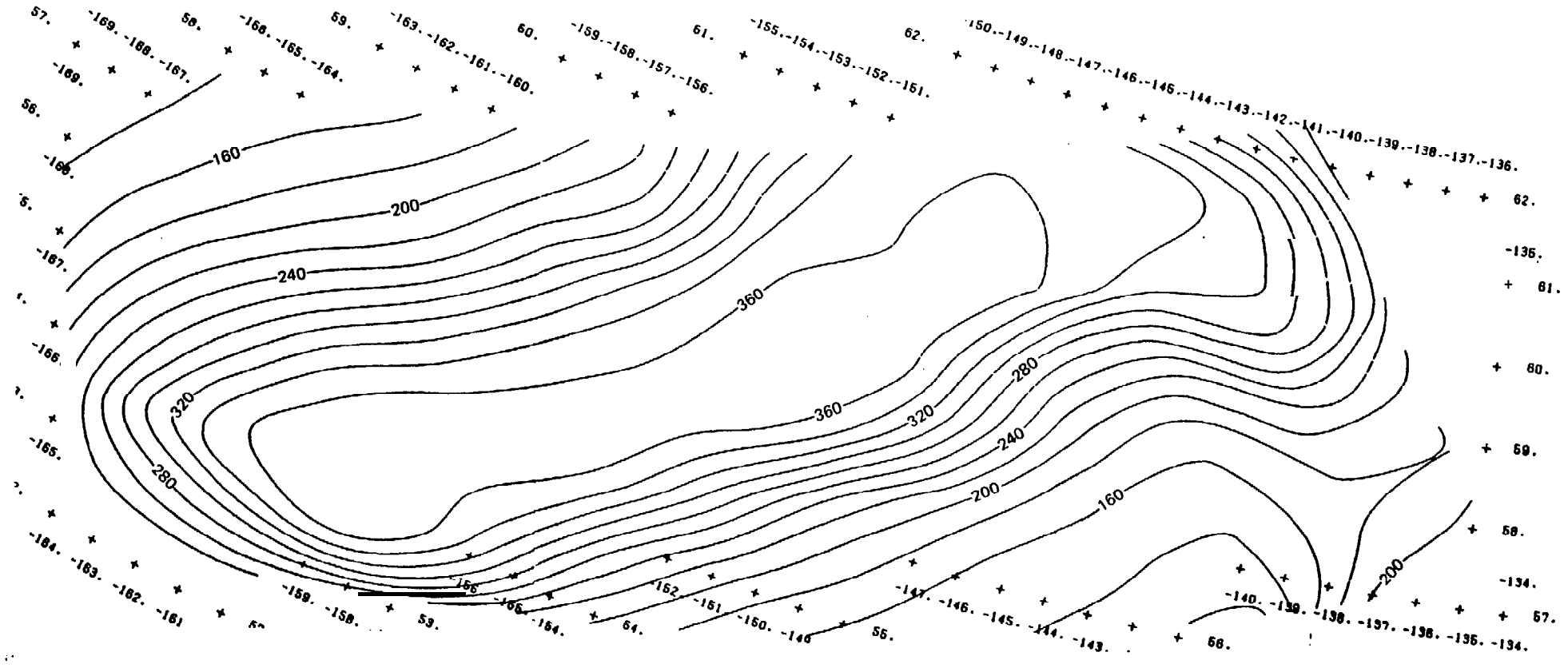


Fig. 12 – PSV (0.8 second 5%)
Probability of Non-exceedence .667

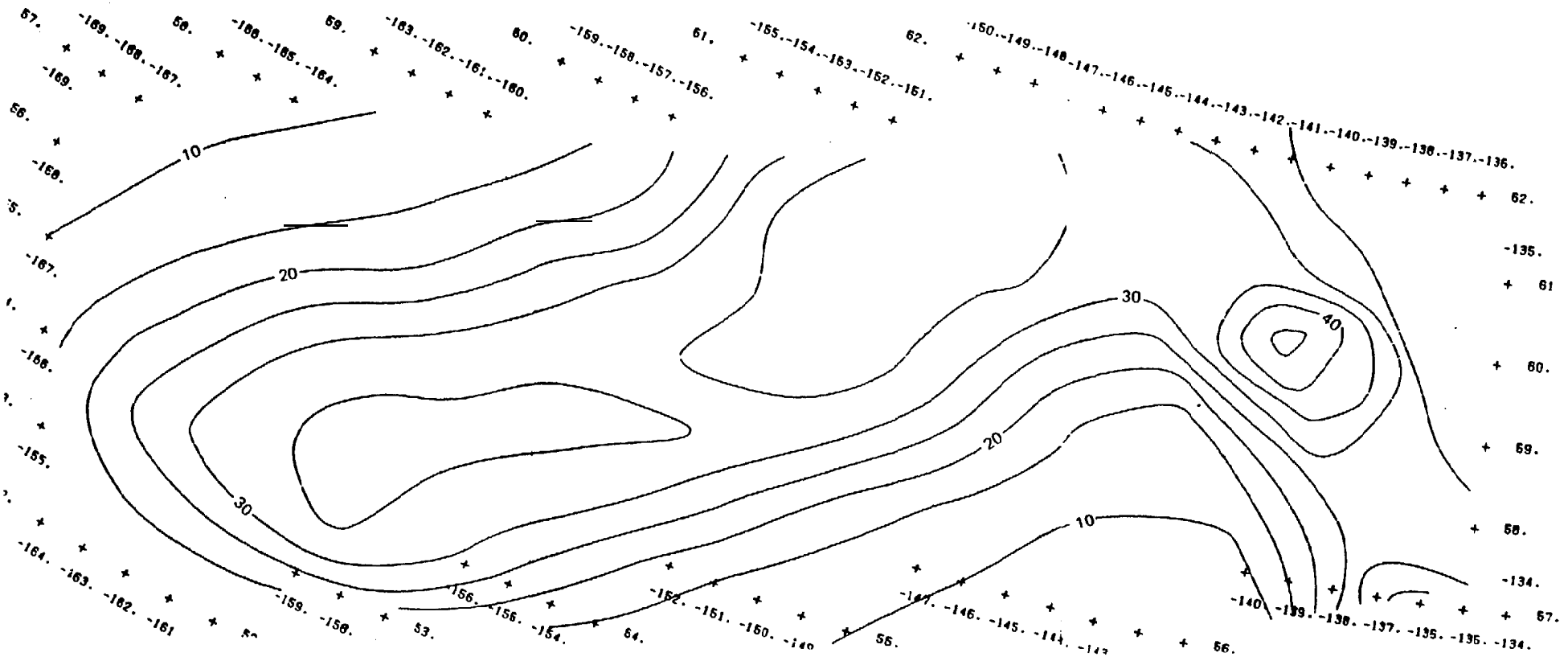
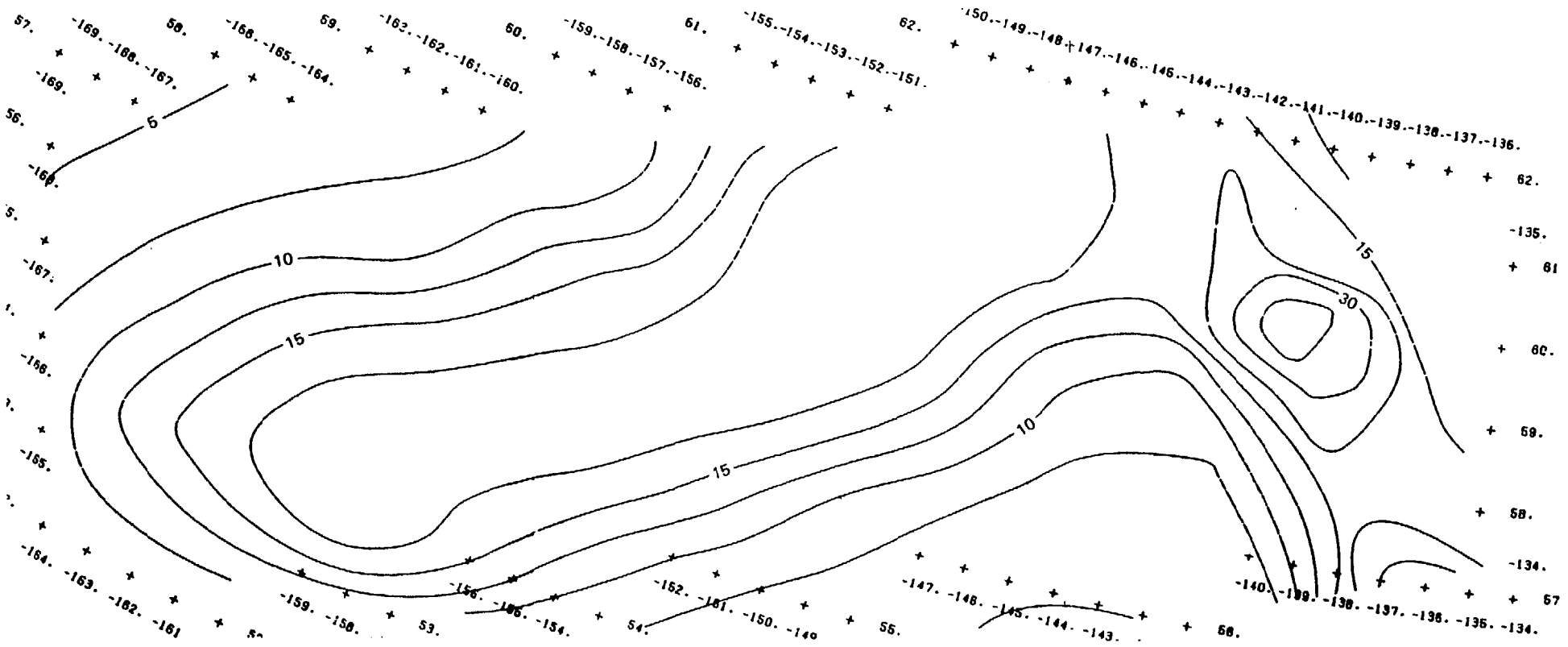


Fig. 11 - Velocity (cm/sec)
Probability of Non-exceedence .667



in seismic gaps along the subduction zone. The future frequency of occurrence, probabilities of occurrence, and earthquake size ($M_s \geq 7.8$ and $M_w \leq 9.05$) have been estimated based upon a semi-Markov simulation. This simulation has used quantified judgments of the SRU participants and available historical seismicity data. Simulation results generate fewer earthquakes of $M_s \geq 7.8$ than the OASES (1978) study. Secondly, the SRU participants felt that, with the project scope of work, the appropriate description of pertinent faulting would involve few onshore faults. Offshore faults and important geologic structural and seismological trends should be included along with the subduction zone and random sources. The areal extent of the subduction zone has increased for the Shumagin Gap and Semidi areas. The focal depth, at 6 km, for the shallow portion of the subduction zone is 1/3 to 1/2 the depth for the previous OASES (1978) results. Thirdly, the SRU participants regarded the typical fault-rupture/magnitude relationships, based on world-wide data, were not adequate for Gulf of Alaska subduction zone tectonics. The choice was made to develop a new relationship which incorporates the concept of fault rupture related to the down-dip width of the subduction zone segments. This relationship has the feature that down-dip rupture widths on the subduction zone are limited to about 200 km, but rupture widths could be as much as four times this width.

Fourthly, an attenuation relationship for maximum horizontal acceleration for stiff-soil sites was modified to accommodate a subduction zone at a closer distance as shallow as 6 km. Maximum magnitude earthquakes on the subduction zone were permitted to have magnitudes as high as 9.05 ± 0.25 M_w. Hence, dispersion in the attenuation relationship at close-in distances could cause artificially high acceleration values. Consequently for earthquakes of M_s or $M_w \geq 8.5$, the attenuation curve for acceleration was adjusted so that they

trend near the value for non-subduction zone sources at around 1 km distance. Although, the subduction source attenuation curve is only valid for distances up to a 6-km closest distance of approach, the participants considered this flattening of the attenuation curve for maximum acceleration to be consistent with the general observation of limiting maximum accelerations in the near-source region of a fault as earthquake magnitudes become larger. In the distance range to 6 to 20 km, the selected attenuation relationship for Source Type B doubles the ground motion values over the WCC (1978) results for the subduction zone.

4.1 Earthquake Recurrence

Above magnitude 7.8 Ms, earthquake recurrence was determined based on the semi-Markov results. A comparison can be made between the expected number of earthquakes to occur over the next 40 years basea on the historical record, assuming a Poisson model, and the semi-Markov model.

Results of the semi-Markov model provide the marginal probability distribution, $p_r(r_{m_i})$ of number of occurrences of each magnitude included in the semi-Markov model. Using this distribution, the expected number of events of magnitude M_i for a given source can be calculated from:

$$E[R_{m_i}] = \sum_{r=0}^{\infty} r_R(r_{m_i})\, r_{m_i} \quad (1)$$

The total expected number of events summed over all magnitudes for a given source is then given by:

$$E[R] = \sum_{\text{all } m_i} E[R_{m_i}] \quad (2)$$

Table 9 shows the values of $E[R_{m_1}]$ and E [R] for each of the sources that were analyzed using a semi -Markov model. The sum of total expected number of events over all sources is also in this table. The total number of expected earthquakes from all sources is 1.50 over the next 40 years (1981 through 2221).

Using the historical data in Table 5, the average number of earthquakes over the next 40-year time period can be estimated. There are 11 earthquakes over a 131-year time period or 12 earthquakes over a 193-year period if the 1788 earthquake is included. The expected number of Ms $\geq$ 7.8 earthquakes over the next 40 years, on a historical record basis, would then be 2.49 to 3.36 earthquakes.

If the recurrence relationships for the subduction sources given in Figure A-3 are simply extrapolated to maximum magnitude values under a Poisson assumption, then about 3. 53 earthquakes would be expected on average over the next 40 years. Hence, the semi-Markov results show that about one-half fewer large earthquakes would be expected to occur in the study region than the Poisson or historical data would indicate.

5.0 APPLICATIONS OF MAPPING PARAMETERS

In the initial use of the SEISMIC.EXPOSURE software package to analyze the Gulf of Alaska, three mapping parameters were considered. The seismic hazard evaluation of the Gulf of Alaska, using the new software package, can serve a variety of potential users because of the program's ability to use a selection of various parameters.

(1) Regulators: Parameters of interest to regulators should be ones that allow an evaluation of the character of ground motions and their likelihood of occurrence in the

proposed lease areas in the Gulf of Alaska, and ones that provide a basis for assessing the adequacy of proposed design strategies meant to prevent the possibility of serious adverse effects.

(2) Industry: Industry would be interested in using the seismic exposure assessment for both pre-lease and post-lease design strategies. In the pre-lease phase of the work, industry would be able to assess the feasibility, costs, and relative desirability of different modes of exploration and construction. In the post-lease phase, industry would be able to select design parameters and evaluate alternate design strategies.

(3) Researchers: The seismic exposure assessment would provide a valuable basis for identifying technical as well as geographic areas which need additional work in order to obtain a better characterization of seismicity and ground- motion characteristics. Additional work based on this information would provide a better basis for the selection of design parameters and for preparing regulations.

Summarized below are the parameters, including the four presented here, that may be useful for these purposes.

Pre-Lease Decisions

1. Identification of Lease Areas Where Seismic Exposure is Significant

The most immediate application of the work will be the identification of those lease areas, or parts of lease areas, where earthquake effects are significant in the evaluation of site suitability and the design of structures. The parameters

selected should provide adequate information for such evaluations; and the basic results, together with limited sensitivity studies, should provide the necessary pre-lease information. Typical ground-motion parameters for such an application are peak values, (e.g., acceleration, velocity, displacement), spectral values, and duration.

2. Seismic Zonation

Regulatory organizations, such as USGS, BLM, and NOAA, or industry organizations, such as API, could use the specific seismic exposure map produced for the Gulf of Alaska as a basis for establishing seismic zonation and design guidelines for similar seismic risk assessments in the various lease areas. Most common parameters for zonation are peak values.

3. Pre-Lease Seismic Decisions

The seismic exposure values calculated will not be seismic design criteria. However, they can be very useful for qualitative cost estimates. In some instances, the results may serve to preclude the consideration of certain structural configurations for use in a particular lease area. If combined with an areal description of soil conditions and properties, the results could be used to identify tracts having potential foundation problems. Parameters useful for this evaluation are the same as in (l).

Design Strategies

4. Site-Specific Studies and Selection of Design Parameters

The results of the proposed work can be a logical starting point for a site-specific study. Results will indicate the general level of expected ground motions at the site.

Although parameters of interest may be the same as in (l), additional evaluations are desirable. These evaluations include: a) the identification of the dominant sources, and b) estimation of the relative contribution of various magnitudes and distances to seismic exposure at a given site. A typical result may be: 70 percent of exposure at Site A is due to M = 6.7 to 7 earthquakes within distances of 30 to 50 km.

5. Relative Costs of Seismic Safety

The results of the SEISMIC.EXPOSURE program can provide exposure values for various return periods. These values can provide an opportunity for the designer or regulator to assess the impact of additional conservatism on structure costs. Parameters most commonly used are peak values and spectral values.

6. Reliability Analysis

The first element of a reliability analysis is a probabilistic description of the environmental forces. Results of the present project will provide this description for the earthquake loads. Parameters most commonly used are peak values.

Research

7. Research and Regional Data-Gathering Programs

Sensitivity studies performed to evaluate the influence of various parameters on seismic exposure can provide the seismologic research units with an opportunity for targeting research efforts in technical and geographic areas where they will be most productive. The exposure model consists of three

elements: source characterization, transmission, and exposure calculation. All elements affect the calculated values, but the relative importance of the first two is not the same for different lease areas. In Lower Cook Inlet, for example, the dominant source is readily recognized to be the Benioff Zone and the principal uncertainty is related to the attenuation relationships. In contrast, the exposure calculation for the northern Bering Sea lease areas is dominated by the "random" or "unidentified" sources. Research in the latter areas should provide better information on specific earthquake sources.

In summary, the parameters for mapping seismic exposure may include the following:

a) Peak Values: peak acceleration, peak velocity, peak displacement.

b) Spectral Values: spectral acceleration, velocity or displacement for periods ranging from 0.1 second to 10 seconds and damping ranging from 2 to 10 percent.

c) Duration.

Return periods for the parameters may range from 50 to 1,000 years. This new seismic exposure evaluation package has the flexibility to provide these seismic exposure mapping parameters for any tectonic environment and, in particular, subduction zone environments of Alaska.

APPENDIX A
INPUTS FOR SEISMIC EXPOSURE EVALUATION

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APPENDIX A
INPUTS FOR SEISMIC EXPOSURE EVALUATION

A.1.0 INTRODUCTION

The purpose of this appendix is to present a compilation of various inputs used for the seismic exposure maps. These inputs consisted of earthquake source location and geometry, earthquake source dimensions, and earthquake source recurrence.

A.2.0 LOCATION AND GEOMETRY OF EARTHQUAKE SOURCES

As described in Section 2.1 of Volume I, earthquake sources are planar in shape or are lines; some consist of a single trapezoidal surface, while others, such as a Benioff zone, consist of multiple bands of trapezoidal surfaces. The elements of a source are defined by the coordinates of its nodal points given as longitude (x), latitude (y), and aepth below surface (z in negative km). Figure 2 of Section 3 (Volume II) shows the nodal points for the elements of the Benioff zone. Figure 3 of Section 3 (Volume II) shows the other nodal points and earthquake sources in the Gulf of Alaska. Table A-1 is a list in serial order of the coordinates of the various nodes. In order to define any source, it is necessary to locate the coordinates of its nodes from Table A-1.

The inclination of the surface of a source represents an average dip interpreted from the assessments based on the seismic and geologic data discussed in Section 3. For computational purposes, horizontal sources are postulated (e.g., random sources) to have a nominal elevation difference of 0. 5 km between the z coordinates at opposite edges. The steeply dipping faults, such as the Denali, have been

TABLE A-1

NODE COORDINATES

Node Index Number	Longitude	Latitude	Depth
1	-158.27	54.72	-5.0
2	-158.27	55.12	-5.5
3	-156.18	55.67	-5.5
4	-155.83	55.30	-5.0
5	-154.32	56.12	-5.0
6	-154.77	56.42	-5.5
7	-152.92	57.40	-5.5
8	-149.39	58.39	-5.0
9	-149.39	58.39	-5.0
10	-149.84	58.67	-5.5
11	-146.10	60.72	-5.5
12	-145.98	60.24	-5.0
13	-143.00	59.26	-5.0
14	-142.99	59.74	-5.5
15	-140.70	60.53	-5.5
16	-140.25	60.19	-5.0
17	-142.000	61.44	-5.5
18	-141.14	61.68	-5.5
19	-139.44	60.45	-5.0
20	-137.44	58.65	-5.5
21	-138.97	59.16	-5.0
22	-140.58	60.08	-5.0
23	-140.13	60.22	-5.5
24	-152.89	55.90	-5.0
25	-153.27	56.26	-5.5
26	-151.72	57.02	-5.5
27	-151.26	56.68	-5.0
28	-148.65	58.04	-5.0
29	-149.26	58.24	-5.5
30	-147.88	59.13	-5.5
31	-147.30	58.91	-5.0
32	-146.64	59.15	-5.0
33	-147.06	59.52	-5.5
34	-145.44	59.82	-5.5
35	-145.00	59.47	-5.0
36	-163.15	51.80	-15.0
37	-163.67	52.70	-15.5
38	-155.18	54.46	-15.5
39	-154.47	53.55	-15.0
40	-145.92	57.28	-15.0
41	-147.21	57.97	-15.5
42	-144.73	59.38	-15.5
43	-142.55	59.20	-15.0
44	-146.80	62.10	-5.0

TABLE A-1
(continued)

Node Index Number	Longitude	Latitude	Depth
45	-151.04	61.34	-5.0
46	-151.08	63.20	-5.0
47	-146.50	63.60	-5.0
48	-143.64	62.97	-5.0
49	-141.43	61.58	-5.0
50	-138.80	61.11	-5.0
51	-135.11	58.99	-5.0
52	-134.47	56.60	-5.0
53	-134.84	55.58	-5.0
54	-139.85	60.30	-5.0
55	-136.71	58.10	-5.0
56	-135.37	56.11	-5.0
57	-132.00	52.15	-5.0
58	-161.87	56.08	-5.5
59	-160.24	54.68	-5.0
60	-156.22	55.66	-5.0
61	-158.26	56.98	-5.5
62	-154.39	58.98	-5.5
63	-149.87	58.64	-5.0
64	-146.17	60.67	-5.0
65	-147.45	62.66	-5.5
66	-140.77	60.50	-5.5
67	-143.02	59.70	-5.0
68	-138.9	62.25	-6.0
69	-144.08	63.92	-6.0
70	-150.12	64.36	-6.0
71	-130.94	53.96	-6.0
72	-132.42	51.87	-5.5
73	-163.70	52.82	-20.0
74	-164.42	53.80	-40.0
75	-161.89	54.38	-40.0
76	-160.76	53.46	-20.0
77	-160.00	52.85	-20.0
78	-165.10	54.67	-125.0
79	-162.88	55.18	-125.0
80	-158.48	55.70	-40.00
81	-159.54	56.40	-125.0
82	-156.44	54.20	-20.0
83	-156.12	53.96	-20.0
84	-153.29	55.35	-20.0
85	-155.77	57.03	-40.00
86	-152.08	58.81	-40.00
87	-149.63	57.04	-6.0
88	-147.78	57.22	-20.0
89	-146.41	58.90	-20.0
90	-150.07	61.63	-40.0

TABLE A-1
(continued)

Node Index Number	Longitude	Latitude	Depth
91	-154.07	59.12	-125.0
92	-151.70	62.70	-125.0
93	-146.52	62.62	-40.0
94	-148.10	63.72	-125.00
95	-148.20	62.16	-40.0

TABLE A-2

NODES FOR SOURCES

Overlay 1

Name	Nodes Used
Deformed Zone	**4, 3, 2, 1** **5, 6, 3, 4** **8, 7, 6, 5** **9, 10, 7, 8** **12, 11, 10, 9** **13, 14, 11, 12** **16, 15, 14, 13**
Offshore Faults	
OS (i)	27, 26, 25, 24
OS (ii)	31, 30, 29, 28
OS (iii)	35, 34, 33, 32
Tarr and Martin Zone	21, 20, 23, 22
Plafker Zone	19, 18, 17, 16
Castle Mountain Fault	44 through 45
Chatham Strait Fault	49 through 53
Denali Faults	46 through 49
Fairweather Fault	54 through 57
Normal Faults	**39, 38, 37, 36** **40, 41, 38, 39** **43, 42, 41, 40**
Random Source	
- Segment 1	60, 61, 58, 59
- Segment 2	63, 62, 61, 60
- Segment 3	111, 65, 62, 63
- Segment 5	67, 66, 65, 64
- Segment 6	66, 68, 69, 65
- Segment 7	72, 71, 68, 66
- Segment 8	110, 70, 112, 62

TABLE A-2
(continued)

Name	Nodes Used
Prince William Sound-Cook Inlet-Kodiak	
PCK Segment 1	113, 86, 85, 84
PCK Segment 2	89, 90, 86, 88
PCK Segment 3	97, 93, 90, 89
Yakataga Gap	98, 101, 100, 99 103, 98, 100, 102
Semidi Gap	84, 85, 80, 83
Shumagin Source	76, 75, 74, 73
Shumagin Gap	82, 80, 75, 77
Deep Benioff Zone	
Segment 1	75, 79, 78, 74
Segment 2	80, 81, 79, 75
Segment 3	86, 91, 104, 85
Segment 4	90, 92, 91, 86
Segment 5	93, 94, 92, 90
Very Deep Benioff Zone (Illiamna)	106, 107, 108, 105

characterized as line sources and not planes since the vertical integration step of 15 km is comparable to the depth distribution of earthquakes on a vertical crustal fault.

A.3.0 EARTHQUAKE SOURCE DIMENSIONS

Individual earthquakes are associated with a rectangular rupture surface. The size of the rupture surface depends upon earthquake magnitude. The magnitude/rupture-lengths used in the analyses are summarized in Section 3 (Volume 11), and are presented in Table A-3.

A.4.0 EARTHQUAKE RECURRENCE

Guidelines developed by the SRU participants for establishing, recurrence on earthquake sources are summarized in Table A-4. The N-M relationship and guidelines for each earthquake source were used as a basis for generating the magnitude distributions shown in Table A-5. For each earthquake source, several entries are given: the number of years for which data are available (75 years); the mean number of occurrences with magnitude $M_s \geq 5.05$; the number of magnitude distributions in magnitude increments of 0. 5 to a maximum magnitude. For sources on the subduction zone that are part of seismic gaps, recurrence inputs were not provided for magnitudes greater than M_s 7.55 $\pm$ 0.25. Above Ms 7.55 $\pm$ 0.25 (7.8 M_s), inputs are provided based on the output from the semi-Markov modeling. The semi-Markov inputs are discussed in detail in Section 3 and are given in Tables 1-8 and B-1 to B-5 (Volume 2) for the initial application to the Gulf of Alaska.

A.5.0 ATTENUATION RELATIONSHIPS

Attenuation relationships utilized in seismic exposure mapping are discussed in detail in Section 3. Attenuation parameters used in SEISMIC.EXPOSURE are listed in Table A-6.

TABLE A-3

RUPTURE LENGTHS USED AS INPUT TO SEISMIC.EXPOSURE

Earthquake Magnitude	Horizontal Rupture Length (km)	Down-Dip Rupture Length (km)
5.05	2.7	2.7
5.55	4.7	4.7
6.05	8.4	8.4
6.55	15.0	15.0
7.05	27.0	27.0
7.55	47.0	47.0
8.05	90.0	50.0
8.55	180.0	70.0
9.05	225.0	80.0

TABLE A-4

SRU EARTHQUAKE RECURRENCE GUIDELINES FOR INPUTS

Source	Maximum Magnitude	Recurrence Information
Castle Mountain Fault	7.5 Ms	One earthquake every 1,200 years; the slip rate is 1/5 times the slip rate for the Denali. (For consistency, the activity rate was taken as 1/5 that of the Denali fault.) (see Figure A-l).
Chatham Strait	7.5 Ms	l/l6 of the Fairweather rate of recurrence (see Figure A-l).
Denali Fault	8.3 M_w	Slip rate is five times the slip rate for the Castle Mountain fault; slip rate is50 times that for the Fairweather; 1/8 of the activity of the Fairweather fault (activity level chosen to reflect one M_S 7.5 earthquake every 125 years on the Denali fault) (see Figure A-l).
Fairweather Fault	8.3 M_w	1 earthquake of Ms 8.0 every 80 years on average; b = 0.75 (see Figure A-l).
Normal Faults	8.0 M_w	Same as the Aleutians OS-3 source (see Figure A-2).

TABLE A-4

(continued)

Source	Maximum Magnitude	Recurrence Information
Prince Willam Sound-Cook Inlet-Kodiak (PCK Segments 1,2,3)	8.9 M_W	Use the Benioff zone shallow BZ-2-1 for Ms < 7.8 (see Figure A-3).
Yakataga Gap	8.9 M_W	Use the Benioff zone shallow BZ-2-1 recurrence curve for M_S < 7.8 (see Figure A-3).
Semidi	8.9 M_w	Use the Benioff zone shallow BZ-2-1 recurrence curve for < 7.8 (see Figure A-3).
Yakutat Block	8.9 M_w	For M < 7.8 5, five times recurrence of Yakataga Gap (Note: Changed to 2 times Yakataga Gap).
Shumagin Gap	8.9	Use BZ-2-1 recurrence curve ($5.0 \leq M_S \leq 7.8$) (see Figure A-3).

TABLE A-4
(continued)

Source	Maximum Magnitude	Recurrence Information
Iliamna Zone	7.8 M_s	Four times the activity of BZ-2-3, with $0.003/(10^3 km^2/yr)$ for $M_s \geq 6$ (see Figure A-4).
Random Sources (Segments 1 through 6, and 8)	7.0 M_s	One earthquake of $M_S \geq 7.0$ every 200 years in the entire zone, or 0.00005 events ($10^3 km^2$ x yr) (see Figure A-5).
Deep Benioff Zone	7.5 M_s	(see Figure A-6).
Plafker Zone	7.0 M_s	Use the Denali recurrence curve for $M_s \leq 7.0$ (see Figure A-7).
Tarr and Martin Zone	8.0 M_s	(see Figure A-8).
offshore Faults and Deformed Zone	7.1 M_s	(see Figure A-9).

TABLE A-5

SOURCE MAGNITUDE DISTRIBUTION

(All values are for a time data base of 75 years, semi-Markov data not included)

Source	Number of Earthquakes 5.05	5.55	6.05	6.55	7.05	7.55
Deformed Zone						
Segment 1	2.592	1.064	0.436	0.169	0.44	
Segment 2	1.836	0.754	0.309	0.119	0.081	
Segment 3	2.304	0.946	0.387	0.150	0.101	
Segment 4	3.168	1.300	0.533	0.206	0.139	
Segment 5	4.068	1.670	0.684	0.264	0.179	
Segment 6	2.916	1.197	0.490	0.190	0.128	
Segment 7	2.52	1.034	0.424	0.164	0.111	
Plafker Zone	2.988	1.226	0.502	0.194	0.131	
Tarr and Martin Special Zone	79.56	25.398	7.994	2.536	0.174	
0s						
Segment 1	3.341	1.361	0.549	0.216	0.087	
Segment 2	2.977	1.213	0.489	0.192	0.078	
Segment 3	2.551	1.040	0.419	0.165	0.067	
Normal Faults						
Segment 1	2.373	1.178	1.16			
Segment 2	2.592	1.286	1.287			
Segment 3	0.982	0.478	0.480			
Random Sources						
Segment 1	48.104	11.861	1.423	0.258	0.049	
Segment 2	80.396	19.822	2.378	0.431	0.081	
Segment 3	95.356	23.51	2.821	0.512	0.096	
Segment 5	47.247	11.649	1.398	0.254	0.048	
Segment 6	81.58	20.114	2.413	0.438	0.082	
Segment 7	199.214	49.116	5.893	1.069	0.201	
Segment 8	121.401	29.932	3.591	0.651	0.123	
Shumagin Source	13.739	5.457	2.183	0.851	0.514	0.046
Shumagin Gap	34.09	3.431	5.416	2.111	1.274	0.114
Semidi Gap	33.512	13.311	5.324	2.075	1.253	0.112

TABLE A-5
(continued)

Source	Distribution of Magnitudes 5.05	5.55	6.05	6.55	7.05	7.55	
PCK Gap							
Segment 1	49.241	19.559	7.823	3.049	1.841	0.165	
Segment 2	48.664	19.329	7.732	3.013	1.819	0.163	
Segment 3	45.967	18.258	7.303	2.846	1.718	0.154	
Yakataga Gap	15.986	6.35	2.54	0.99	0.598	0.053	
Yakutat Gap	120.726	48.807	19.523	7.847	4.594	0.411	
Deep Benioff Zone							
Segment 1	6.602	3.668	1.956	1.076	1.339	0.018	
Segment 2	9.801	5.445	2.904	1.597	1.988	0.027	
Segment 3	8.303	4.613	2.460	1.353	1.988	0.027	
Segment 4	10.328	5.738	3.06	1.683	2.095	0.029	
Segment 5	17.213	9.563	5.1	2.805	3.492	0.048	
Segment 6	12.231	6.795	3.624	1.993	2.481	0.034	
Iliamna Zone	12.474	6.93	3.696	2.033	2.531	0.035	
Castle Mountain Fault	4.374	1.814	0.812	0.314	0.156	0.03	
Denali Fault	21.87	9.07	4.06	1.57	0.778	0.253	0.15
Chatham Strait Fault	10.94	4.53	2.03	0.783	0.389	0.013	
Fairweather Fault	174.98	72.53	32.48	12.53	6.225	2.025	1.2

TABLE A-6

ATTENUATION PARAMETERS USED IN INPUT TO SEISMIC.EXPOSURE

Parameter		B1	B2	B3	B4	ln(sig)	mag max
-Acceleration	(1)	190.67	0.823	0.0	1.561	0.568	0.0
(cm/sec^2)	(2)	210.	0.50	0.0	0.85	0.606	0.0
Velocity	(1)	0.836	1.22	0.0	1.43	0.652	0.0
(cm/sec	(2)	5.33	0.72	0.0	1.05	0.666	0.0
Psv							
(0.8 sec 5%)	(1)	0.317	1.52	0.0	1.57	0.877	6.5
	(2)	5.26	0.781	0.0	1.05	0.821	0.0

for PSV attenuation (1) when M ½ 6.5,
B1 = 6.13 and B2 = 1.06

Note: Attenuation 1 is used for depths less than 6.0 km. Attenuation 2 is used for greater depths.

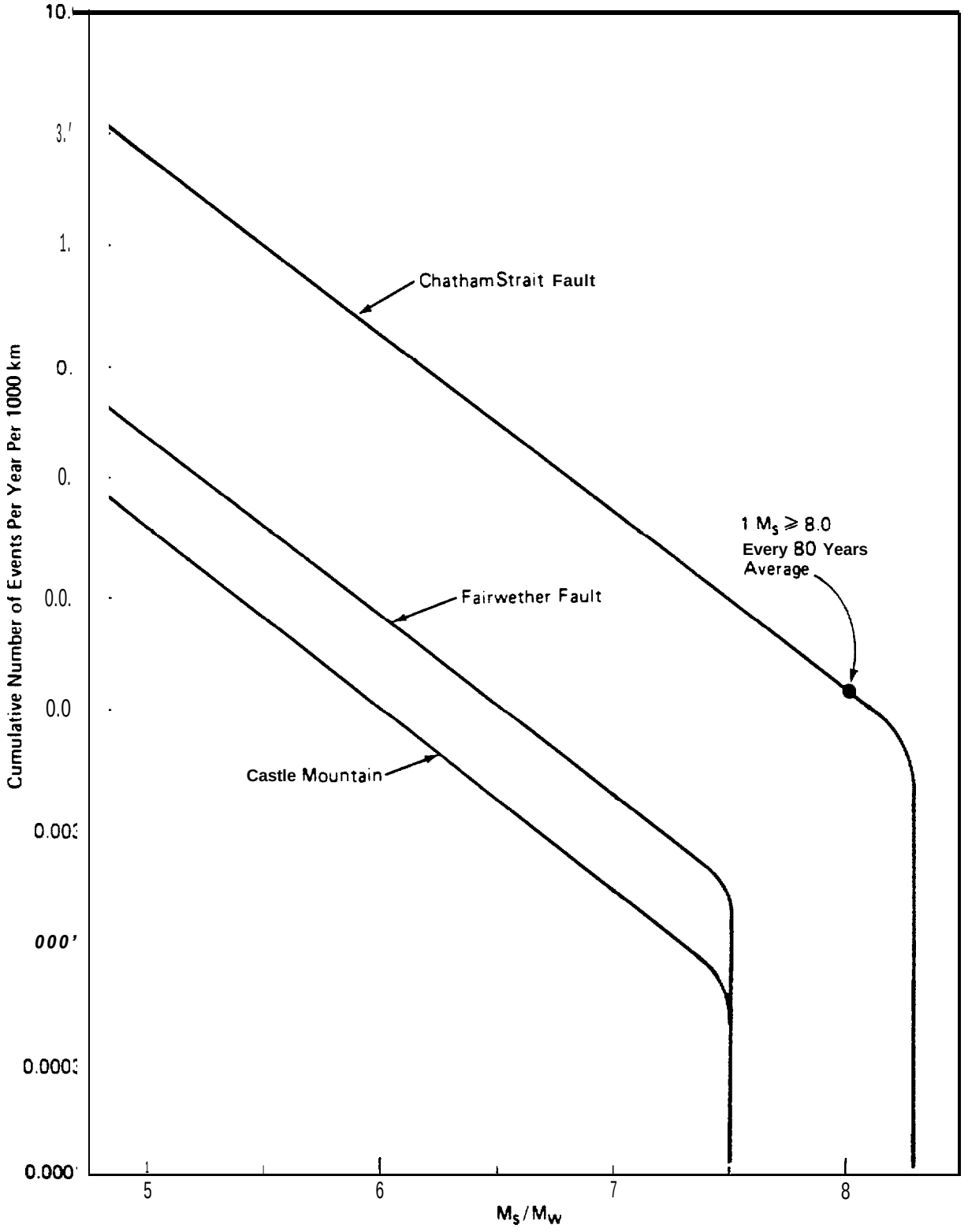

Fig. A-1 - Recurrence relation for the four line sources

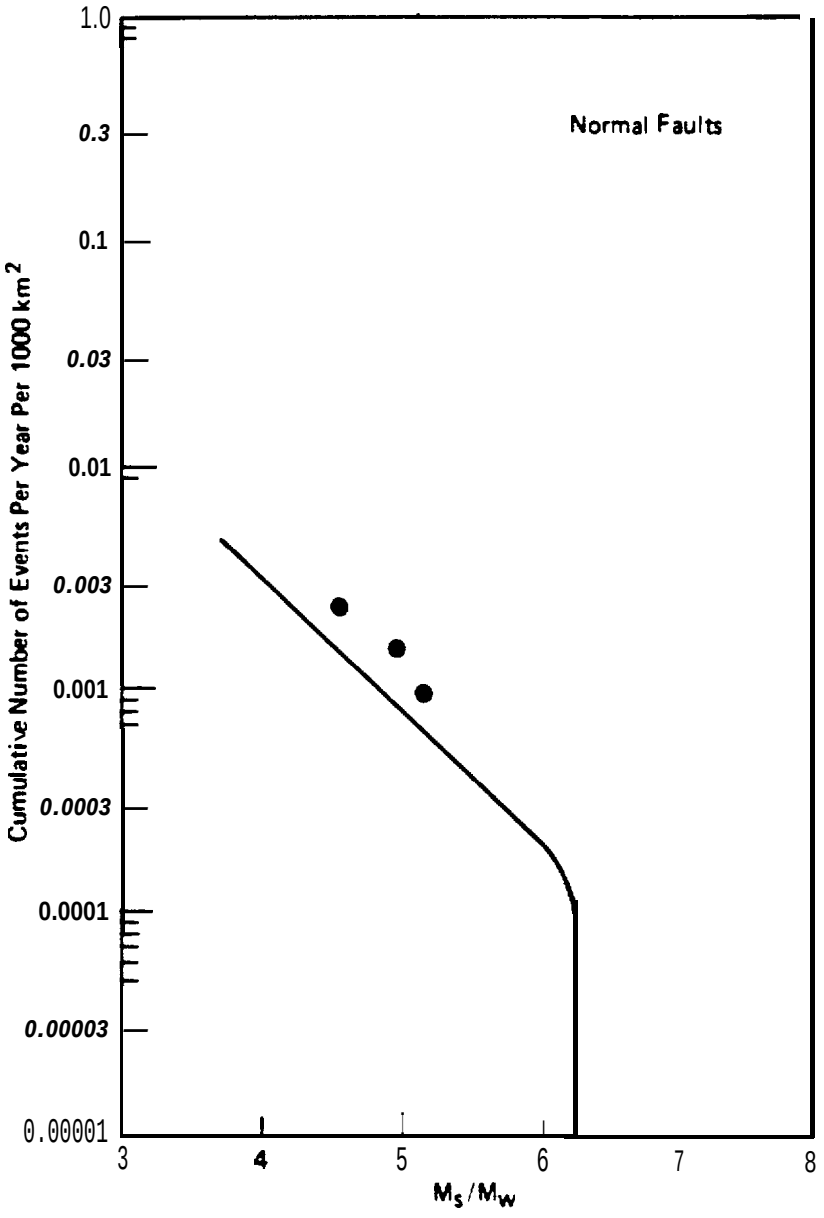

Fig. A-2 - Recurrence relation for Gulf of **Alaska** normal faults

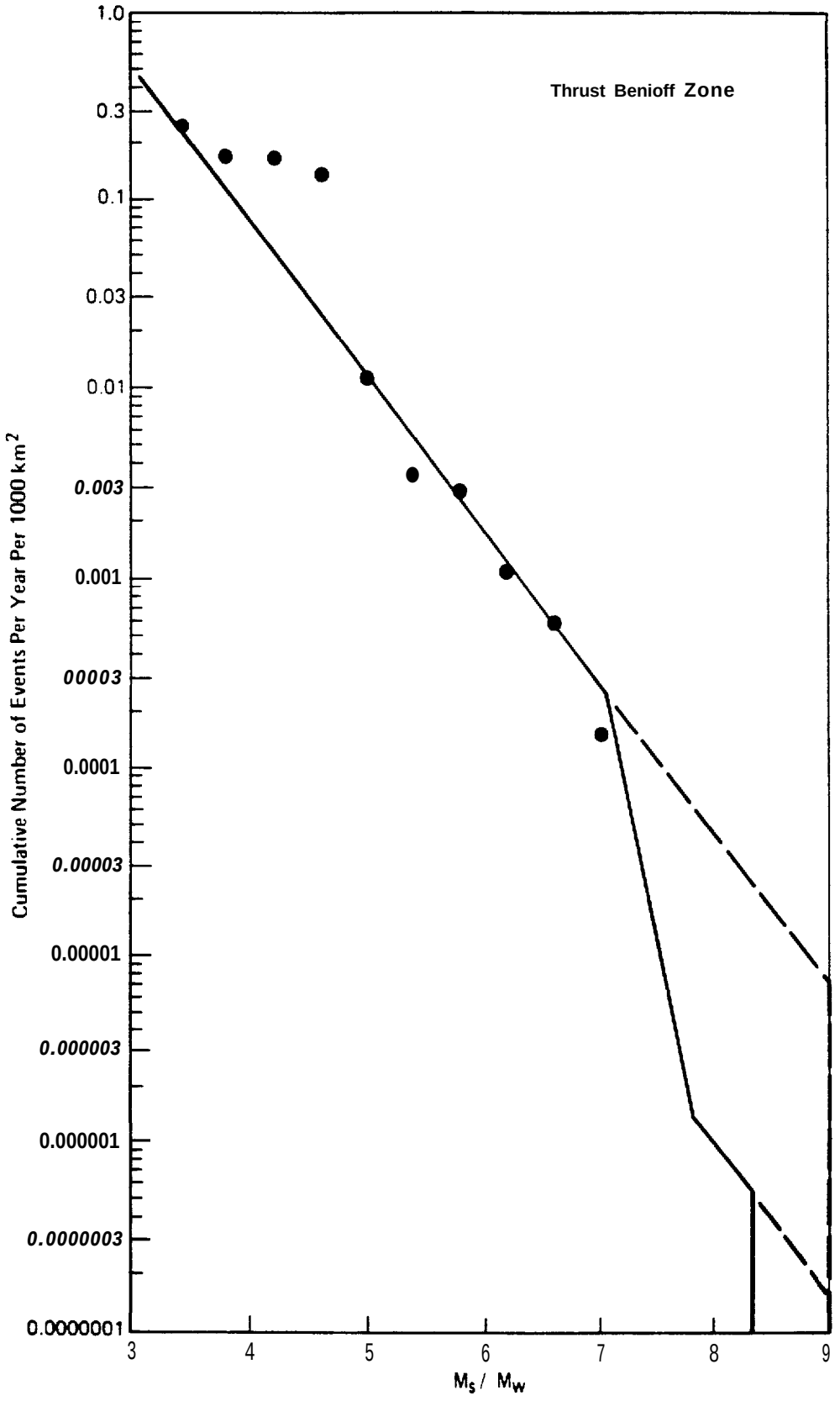

Fig. A-3 - Recurrence Relation for the Gulf of Alaska Thrust Benioff Zone

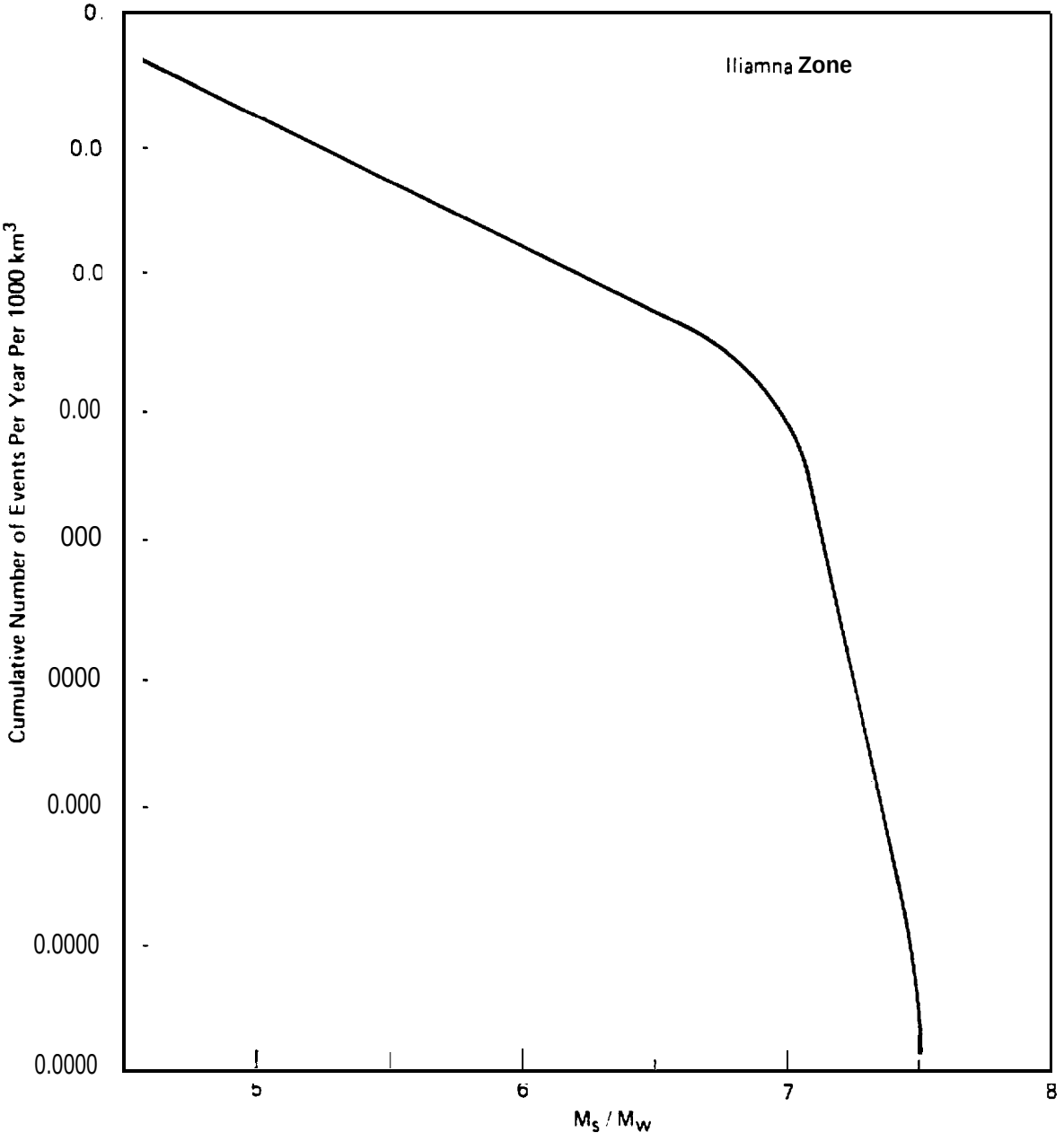

Fig. A-4 - Recurrence Relationship for the Iliamna Zone

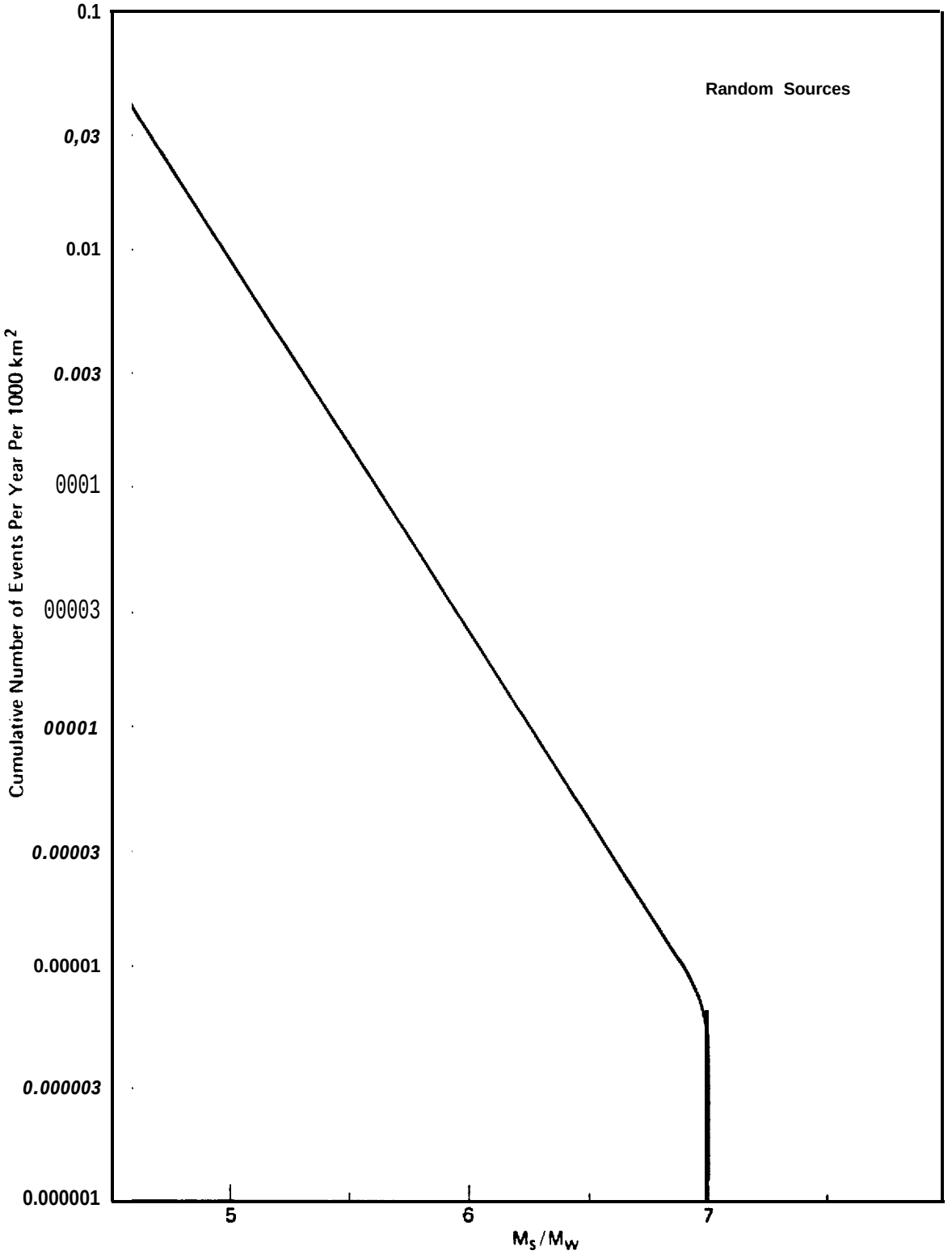

Fig. A-5 - Recurrence Relation for the Gulf of Alaska Random Sources

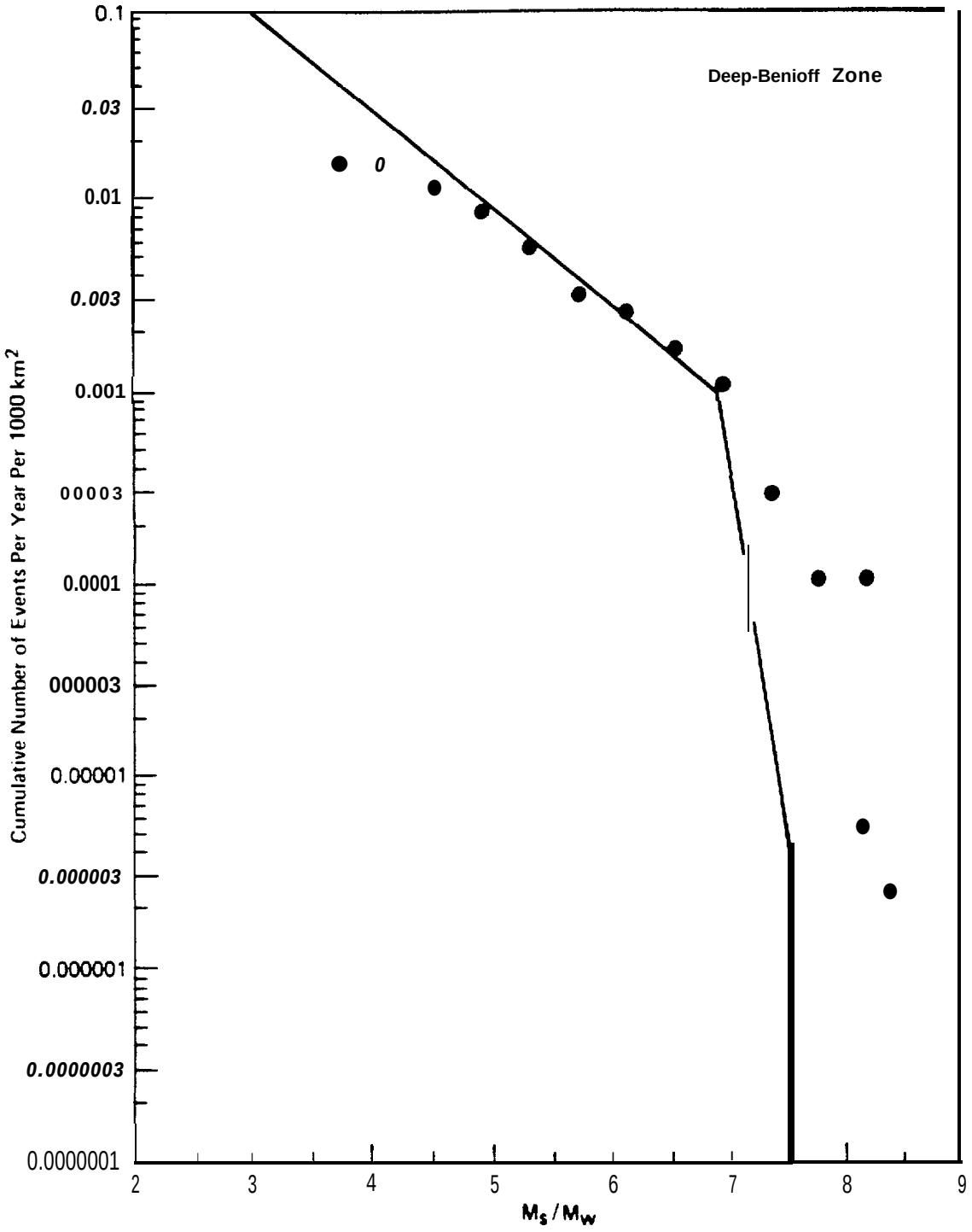

Fig. A-6 - Recurrence Relation for the Gulf of Alaska Deep Benioff Zone

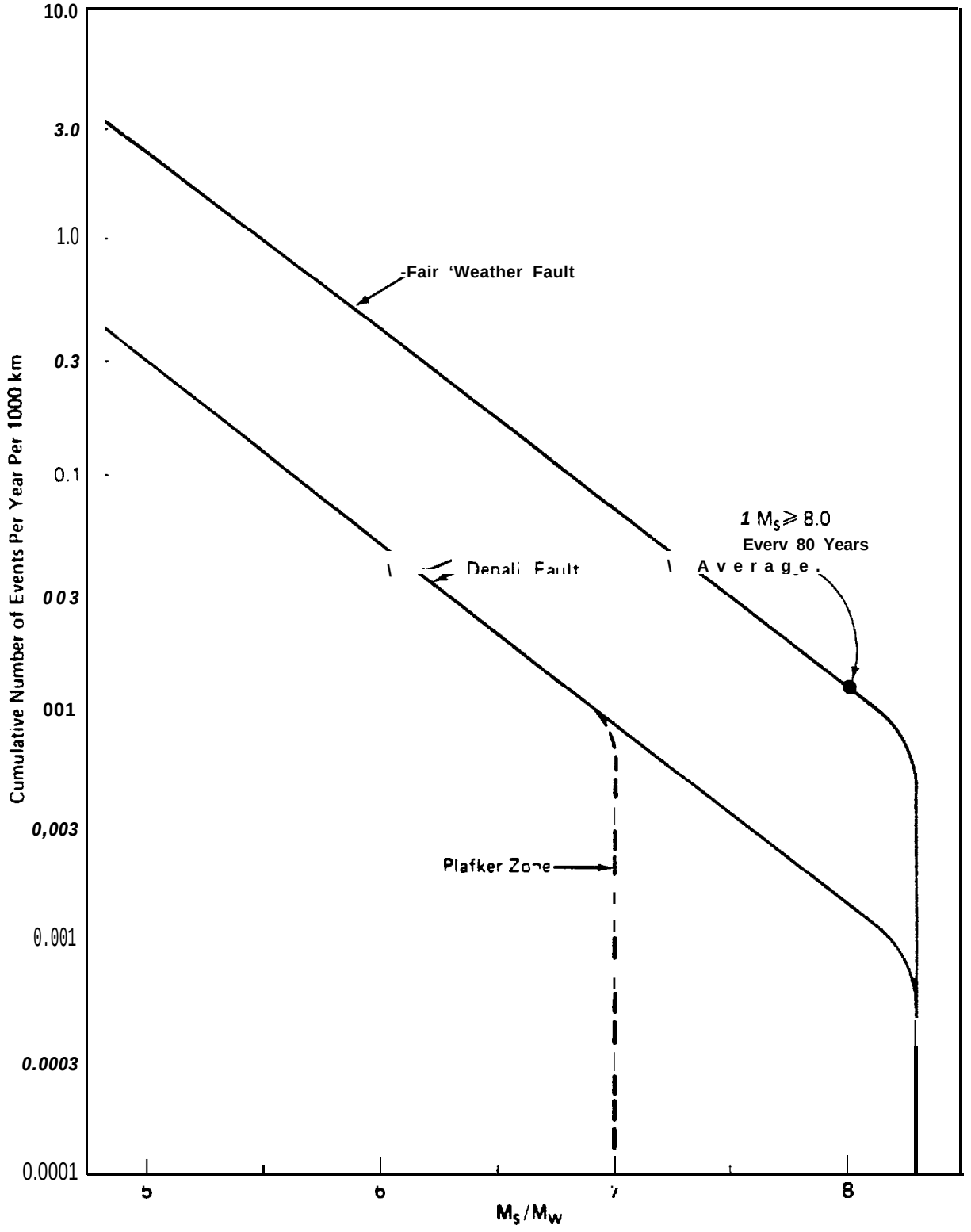

Fig. A-7 - Recurrence Relation for the Plafker Zone

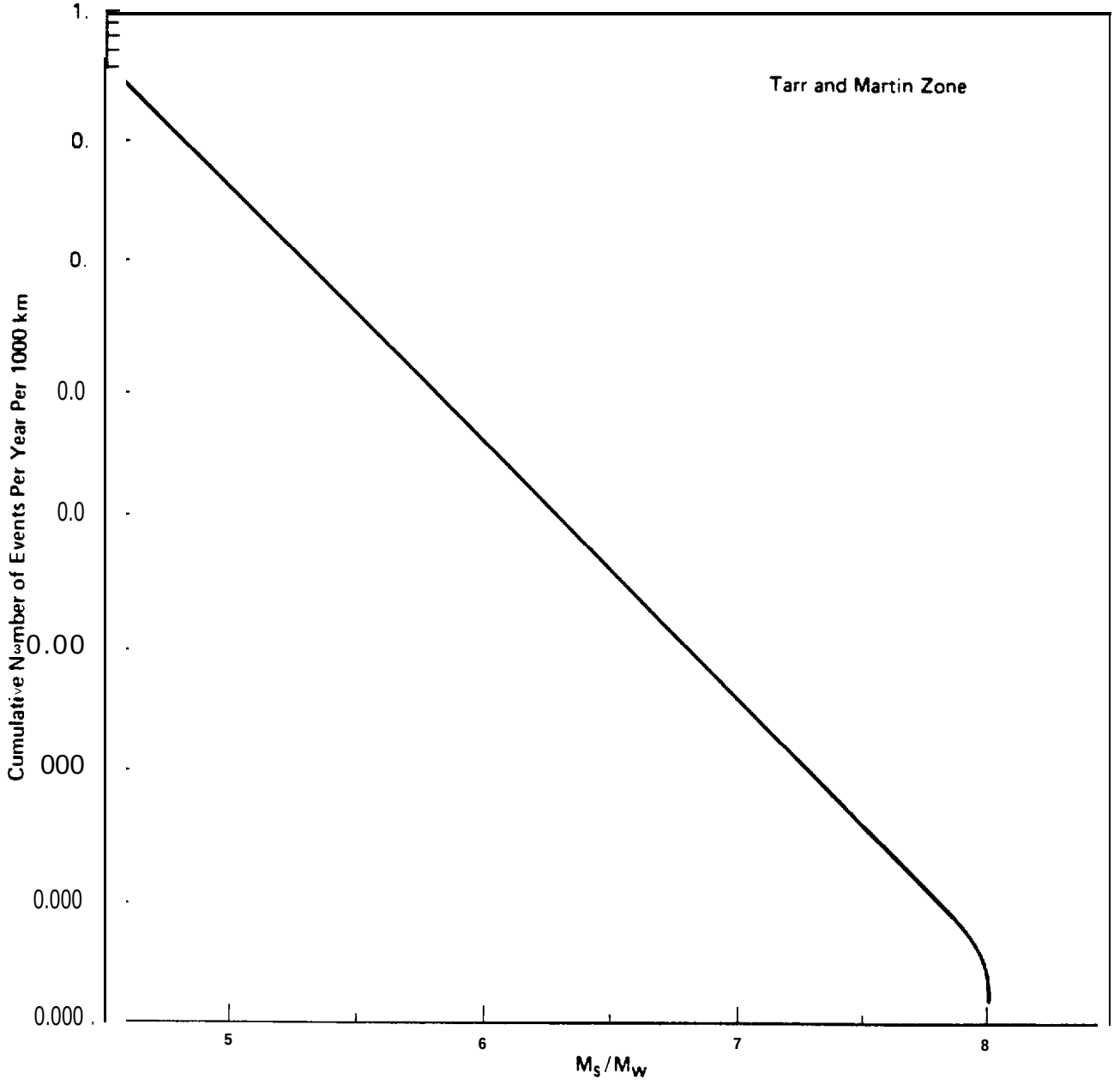

Fig. A-8 - Recurrence Relation for the Tarr and Martin Zone

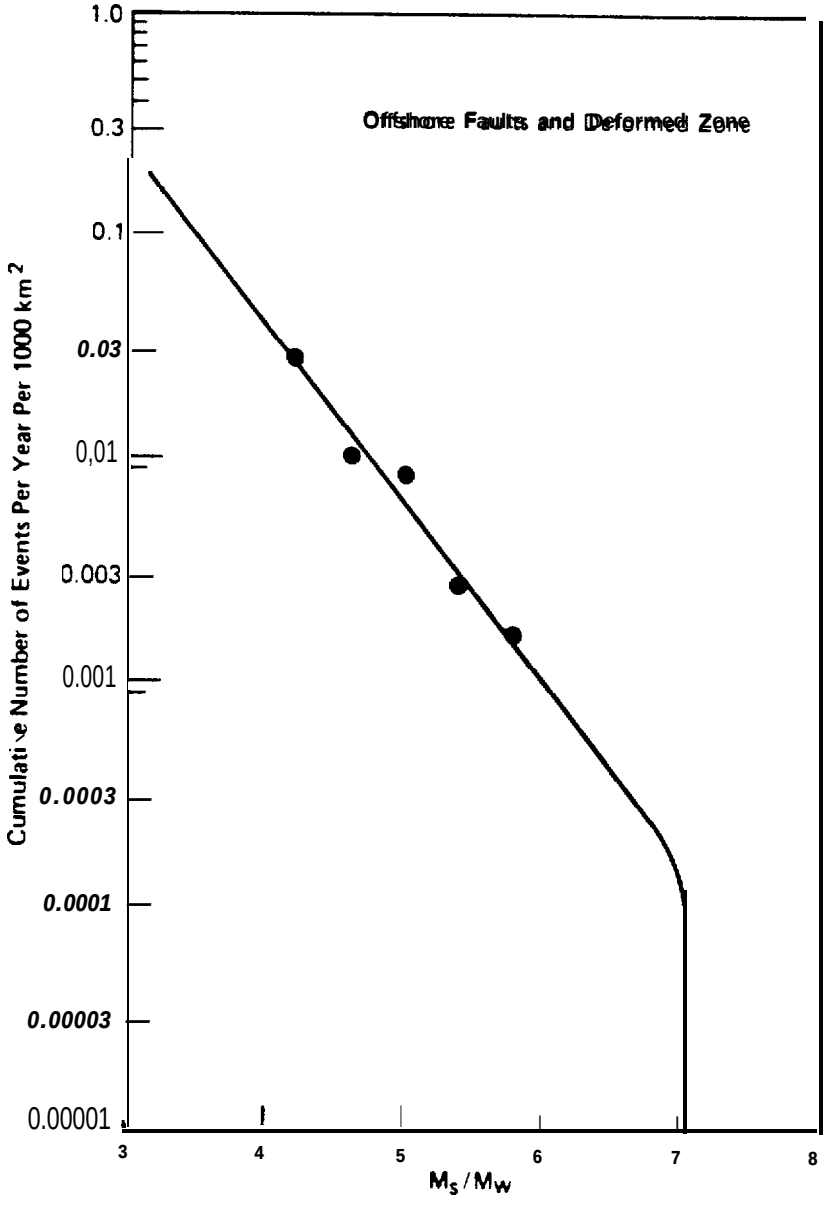

Fig. A-9 - Recurrence Relation for the Gulf of Alaska Offshore Faults and Deformed Zone

A.6.0 PROGRAM OUTPUT

Input to the program consists of the geometry in Tables A-1 and A-2, seismicity in Table A-5, rupture lengths in Table A-3, and attenuation in Table A-6. These were combined with the output from program MARKOV (discussed in Appendix B). Partial SEISMIC.EXPOSURE output is shown in Figure A-10.

Fig. A- ⊙ SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site.

```
NOAA SEISMIC EXPOSURE MAPS--GULF OF ALASKA  -OCT  1961
MARKOV INPUT USED

PLOTTER SIZE                        30
PLOT PROJECTION                      1
STANDARD LATITUDE 1                 35.0000
STANDARD LATITUDE 2                 67.0000
STANDARD LONGITUDE                 -153.0000
SCALING FACTOR                     2500000.
NUMBER OF AREA SOURCES              37
NUMBER OF LINE SOURCES               4
NUMBER OF NODES                    113
NUMBER OF ELEMENTS                  37
NUMBER OF GRIDS                      1
NUMBER OF VARIABLES                  3
NUMBER OF ATT/VARIABLE               2
LINES PRINTED PER SITE               5
MAX NO. OF MAG                       9

SAVE RESULTS ON DISK (PLOTTING FORMA      50  VALUES PER SITE


 IME PERIOD    MAG INC    SMALLEST MAG
     40.00       .50        5.05

NODAL COORDINATES        13  NODES)
INDEX    WCC INDEX        X COORD        Y COORD          Z (KM)          X (KM)          Y (KM)
    1            1       -158.270         54.720         -5.000         332.006         258.084
    2            2       -158.570         55.110         -5.500         316.702         302.271
    3            3       -156.180         55.670         -5.500         466.047         352.456
    4            4       -155.830         55.300         -5.000         485.736         311.873
    5            5       -154.320         56.120         -5.000         579.792         397.317
    6            6       -154.770         56.420         -5.500         553.559         430.138
    7            7       -152.920         57.400         -5.500         663.705         534.345
    8            8       -152.400         57.110         -5.000         694.205         503.250
    9            9       -149.390         58.390         -5.000         863.635         646.180
   10           10       -149.840         58.670         -5.500         836.839         675.207
   11           11       -146.100         60.720         -5.500        1025.805         910.818
   12           12       -145.980         60.240         -5.000        1037.176         859.549
   13           13       -143.000         59.260         -5.000        1211.356         773.093
   14           14       -142.990         59.740         -5.500        1204.789         824.650
   15           15       -140.700         60.530         -5.500        1314.169         928.218
   16           16       -140.250         60.190         -5.000        1344.319         895.994
   17           17       -142.000         61.440         -5.500        1230.605        1019.992
   18           18       -141.340         61.680         -5.500        1270.672        1047.807
   19           19       -139.440         60.450         -5.000        1382.146         931.581
   20           20       -137.440         58.650         -5.500        1526.579         762.369
   21           21       -138.970         59.160         -5.000        1433.649         799.112
   22           22       -140.580         60.080         -5.000        1328.781         881.172
   23           23       -140.130         60.220         -5.500        1350.130         900.332
   24           24       -152.890         55.900         -5.000         665.694         372.959
   25           25       -153.270         56.260         -5.500         642.895         411.661
   26           26       -151.720         57.020         -5.500         734.211         494.075
   27           27       -151.260         56.660         -5.000         762.090         458.055
   28           28       -148.650         58.040         -5.000         907.780         610.762
   29           29       -149.260         58.240         -5.500         871.627         630.360
   30           30       -147.880         59.130         -5.500         943.475         731.072
   31           31       -147.300         58.910         -5.000         977.491         709.797
   32           32       -146.640         59.150         -5.000        1012.012         738.652
   33           33       -147.060         59.520         -5.500         985.497         776.596
```

Fig. A- [illegible] - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

34	34	-145.440	59.620	-5.500	1070.877	817.160
35	35	-145.000	55.470	-5.000	1096.905	782.037
36	36	-163.150	51.800	-15.000	-1[illegible].796	-19.846
37	37	-163.670	52.700	-15.500	-32.911	80.445
38	38	-155.180	54.460	-15.500	52[illegible].634	220.399
39	39	-154.470	53.550	-15.000	565.223	121.732
40	40	-145.420	57.260	-15.000	1071.427	541.461
41	41	-147.210	57.970	-15.500	990.564	608.961
42	42	-144.730	59.380	-15.500	1114.791	774.014
43	43	-142.550	59.200	-15.000	1236.971	770.154
44	44	-146.800	62.100	-5.000	975.921	1057.240
45	45	-151.040	61.340	-5.000	761.561	962.264
46	46	-151.080	63.200	-5.000	754.116	1165.378
47	47	-146.500	63.600	-5.000	976.581	1222.203
48	48	-143.640	62.970	-5.000	1124.496	1168.841
49	49	-141.430	61.560	-5.000	1257.568	1034.639
50	50	-138.800	61.110	-5.000	1401.963	1008.454
51	51	-135.110	58.990	-5.000	1647.404	827.856
52	52	-134.470	56.600	-5.000	1746.833	587.254
53	53	-134.840	55.580	-5.000	1752.606	475.531
54	54	-139.850	60.300	-5.000	1363.446	911.556
55	55	-136.710	56.100	-5.000	1581.670	713.375
56	56	-135.370	56.110	-5.000	1707.684	522.981
57	57	-132.000	52.150	-5.000	2023.716	168.765
58	58	-161.870	56.080	-5.500	127.207	424.704
59	59	-160.240	54.680	-5.000	209.674	264.302
60	60	-156.220	55.660	-5.000	463.573	351.489
61	61	-156.260	56.980	-5.500	350.138	500.261
62	62	-154.390	56.960	-5.500	561.468	705.595
63	63	-149.870	58.640	-5.000	835.292	671.897
64	64	-146.170	60.670	-5.000	1022.603	905.059
65	65	-147.950	62.660	-5.500	938.112	1115.599
66	66	-140.770	60.500	-5.500	1311.020	924.379
67	67	-143.020	59.700	-5.000	1203.756	820.133
68	68	-138.900	62.250	-6.000	1372.900	1129.408
69	69	-144.060	63.920	-6.000	1089.994	1269.620
70	70	-150.120	64.360	-6.000	796.588	1294.394
71	71	-130.940	53.960	-6.000	2032.720	374.236
72	72	-132.420	51.870	-5.500	2005.517	132.174
73	73	-163.700	52.620	-20.000	-32.962	93.448
74	74	-164.420	53.800	-40.000	-62.768	204.253
75	75	-161.890	54.360	-40.000	103.865	243.687
76	76	-160.760	53.460	-20.000	163.612	137.541
77	77	-160.000	52.850	-20.000	205.769	67.559
78	78	-165.130	54.670	-125.000	-89.944	303.210
79	79	-162.880	55.180	-125.000	53.934	336.703
80	80	-158.480	55.700	-40.000	326.902	363.961
81	81	-159.540	56.400	-125.000	269.555	444.154
82	82	-156.440	54.200	-20.000	442.034	195.577
83	83	-156.120	53.960	-20.000	461.833	168.959
84	84	-153.29[illegible]	55.350	-20.000	641.309	313.912
85	85	-155.77[illegible]	57.030	-40.000	496.476	497.561
86	86	-152.010	56.810	-40.000	710.037	666.805
87	87	-149.630	57.040	-6.000	856.772	500.140
88	88	-147.780	57.220	-20.000	963.772	525.870
89	89	-146.410	58.900	-20.000	1027.164	712.862
90	90	-150.070	61.630	-40.000	811.300	995.535
91	91	-154.07[illegible]	59.130	-125.000	599.550	720.433
92	92	-151.700	[illegible].700	-125.000	724.399	1109.929
93	93	-146.5[illegible]0	62.620	-40.000	985.147	1115.059

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska, Output for a Single Site (continued).

94	94	-148.100	63.720	-125.000	697.671	1229.246
95	95	-148.200	62.160	-40.000	904.057	1058.378
96	96	-144.840	59.360	-6.000	1169.486	766.878
97	97	-143.350	59.740	-20.000	1185.279	822.002
98	98	-139.340	59.880	-15.000	1398.936	871.826
99	99	-146.520	62.620	-40.000	985.147	1115.099
100	100	-145.300	61.580	-15.000	1058.307	1008.142
101	101	-148.980	61.210	-40.000	1287.255	998.655
102	102	-142.870	59.300	-1..000	1217.890	778.372
103	103	-136.000	57.000	-12.000	1648.777	607.220
104	104	-157.040	57.660	-125.000	425.762	568.8.8
105	105	-152.350	59.570	-75.000	694.765	768.859
106	106	-151.930	60.290	-75.000	716.694	847.173
1111	107	-153.680	60.500	-160.000	622.632	869.717
134	108	-154.050	59.790	-160.000	601.707	792.9*3
109	109	-147.450	62.660	-5.000	938.112	1115.599
110	110	-144.160	64.020	-5.560	1083.858	1279.956
111	111	-146.130	60.560	-5.000	1025.851	893.363
112	112	-153.400	62.780	-6.000	638.993	1110.ISR
113	113	-148.460	57.530	-/0.000	922.053	556.544

ELEMENTS DESCRIPTION (37 ELEMENTS)

INDEX	I	J	K	L	RENUMBERED	I	J	R	L
1	4	3	2	1		4	3	2	1
2	5	6	3	4		5	b	3	4
3	8	7	b	5		8	7	b	5
4	9	10	1	8		9	10	7	8
5	12	11	10	9		12	11	10	9
6	13	14	11	12		13	14	11	12
7	16	15	14	13		16	15	14	13
8	19	18	17	16		19	18	17	16
9	21	20	23	22		21	20	23	22
10	27	26	25	24		27	26	25	24
11	31	30	29	28		31	30	29	28
12	35	34	33	32		35	34	33	32
13	39	38	37	36		39	38	37	36
14	40	41	38	39		40	41	38	39
15	43	42	41	40		43	42	41	40
16	60	61	58	59		60	61	58	59
17	63	b.	61	60		63	62	61	60
18	111	65	62	63		111	65	62	63
19	67	66	65	64		67	66	65	64
20	66	68	69	65		66	68	69	65
21	72	71	68	66		72	71	68	66
22	110	70	112	62		110	70	112	62
23	76	75	74	73		76	75	74	73
24	82	80	75	77		82	80	15	77
25	84	85	80	83		84	85	80	83
26	113	86	85	84		113	86	85	84
27	89	90	66	88		89	90	86	88
28	97	93	90	89		97	93	90	89
29	98	101	99	100		98	101	99	100
30	103	91	100	102		103	98	100	102
31	75	79	78	74		75	79	78	74
32	80	81	79	75		80	81	79	75
33	85	in.J	61	80		85	104	81	80
34	86	91	104	85		66	91	104	85
35	90	92	91	86		90	92	91	66
36	93	94	92	90		93	94	92	90
37	106	107	108	105		106	107	108	105

Fig. A-10 -SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
AREA SOURCE     1
----------------

DEFORMED ZONE SEGMENT 1
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  1  THRU  1
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE      1
TIMEDATABASE.............      75.000
NO OF OCC................       4.376
NO OF POISSONMAG.........       5
SUM of POISSON OCC.......       4.315
DISTRIBUTION of MAG.
        5.050        5.550        6.050        6.550        7.050
        2.552        1.764         .436         .164         .114
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     2
----------------

DEFORMED ZONE SEGMENT 2
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  2  THRU  2
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE      1
TIMEDATABASE.............      75.000
NO OF OCC................       3.096
NO OF POISSONMAG.........       5
SUM OF POISSON OCC.......       3.099
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        1.836         .754         .309         .119         .081
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     3
----------------

DEFORMED ZONE SEGMENT 3
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  3  THRU  3
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE      1
TIMEDATABASE.............      75.000
NO OF OCC................       3.886
NO OF POISSONMAG.........       5
SUM OF POISSON OCC.......       3.886
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        1.394         .946         .387         .150         .131
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     4
----------------

DEFORMED ZONE SEGMENT 4
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  4  THRU  4
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE      1
TIMEDATABASE.............      75.000
NO OF OCC................       5.346
NO OF POISSONMAG.........       5
SUM OF POISSON OCC.......       5.346
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        1.[illegible]        1.[illegible]         .[illegible]         .206         .139
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE
```

Fig. A- 0 SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
AREA SOURCE     5
----------------

DEFORMED ZONE SEGMENT 5
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  5 THRU   5
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..... 75.000
NO OF OCC ..... 6.865
NO OF POISSON MAG. ..... 5
SUM OF POISSON OCC. ..... 6.865
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        4.068        1.670         .684         .264         .179
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     6
----------------

DEFORMED ZONE SEGMENT 6
NUMBER OF BANDS: 1    BOUNDARY COND.           0     0     0    ELEMENTS:  6 THRU   6
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..... 75.000
NO OF OCC ..... 4.921
NO OF POISSON MAG. ..... 5
SUM OF POISSON OCC. ..... 4.921
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        2.916        1.197         .490         .190         .128
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     7
----------------

DEFORMED ZONE SEGMENT 7
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  7 THRU   7
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..... 75.000
NO OF OCC ..... 4.253
NO OF POISSON MAG. ..... 5
SUM OF POISSON OCC. ..... 4.253
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        2.520        1.014         .424         .164         .111
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     8
----------------

PLATEAU ZONE
NUMBER OF BANDS: 1    BOUNDARY COND:     1     0     0     0    ELEMENTS:  8 THRU   8
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..... 75.000
NO OF OCC ..... 5.041
NO OF POISSON MAG. ..... 5
SUM OF POISSON OCC. ..... 5.041
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050
        2.966        1.221         .501         .194         .131
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

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AREA  SOURCE  9
------ -------- --

JAKRAKO MARTIK SPECIAL ZONE
NUMBER OF BANDS: 1   BOUNDARY COND:    1    0    u    u   ELEMENTS:  9   THRU 9
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIMEDATABASE.............      75.000
NO of OCC................     136.662
NO OF POISSONMAG.........        .
SUM OF POISSON O(C.......     115.66
DISTRIBUTION OF MAG.
       5.050        5.550        6.050        6.550        7.050
      79.560       25.398        1.994        2.536         .174
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE   10
------------  ----

 OS -1 III
NUMBER OF BANDS: 1   BOUNDARY COND:    1    0    u    u   ELEMENTS: 10 THRU 10
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE............      75.000
NO or OCC................       5.554
NO Of POISSONMAG.........       5
SUM Of POISSONOCC........       5.554
DISTRIBUTION Of MAG.
       5.050        5.550        6.050        6.550        7.050
       1.341        1.361         .549         .216         .087
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AH, A  SOURCE 11
--------- -------

 OS - 1  (III)
NUMBER OF BANDS : 1   BOUNDARY COND:    1    u    o    0   ELEMENTS: 11 THRU 11
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIMEDATABASE.............      75.000
NO OF OCC................       4.946
NO OF POISSONMAG.........       5
SUM OF POISSONOCC........       ● .9**
DISTRIBUTION Of MAG.
       5.050        5.550        6.050        6.550        7.050
       2.977        1.213         .489         .192         .078
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE   12
------ .---------

 0" - 1 (III)
NUMBER Of BANDS: 1   BOUNDARY COND:    1    u    o    u   ELEMENTS: 12 THRU 12
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONEL    1
TIMEDATABASE.............      75.000
NO OF OCC................       4.241
NO OF POISSONMAG.........       5
SUM OF POISSON OCC.......       4.24
DISTRIBUTION of MAG.
       5.050        5.550        6.050        6.550        7.050
       2.551        1.047         .419         .165         .067
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

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AREA SOURCE    13
----------------

NORMAL FAULTS SEGMENT 1
NUMBER OF BANDS: 1   BOUNDARY COND:    0    0    0    0   ELEMENTS    3 THRU    3
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
  ME DATA BASE ..............      75.000
NO OF OCC ....................      4.710
NO OF POISSON MAG. ..........       3
SUM OF POISSON OCC. .........       4.711
DISTRIBUTION OF MAG.
        5.050        5.550        6.050
        2.373        1.178        1.160
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE    14
----------------

NORMAL FAULTS SEGMENT 2
NUMBER OF BANDS: 1   BOUNDARY COND:    0    0    0    0   ELEMENTS: 14 THRU   14
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..............      75.000
NO OF OCC ....................      5.144
NO OF POISSON MAG. ..........       3
SUM OF POISSON OCC. .........       5.145
DISTRIBUTION OF MAG.
        5.050        5.550        6.050
        2.592        1.286        1.267
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE    15
----------------

NORMAL FAULTS SEGMENT 3
NUMBER OF BANDS: 1   BOUNDARY COND:    0    0    0    0   ELEMENTS:  5 THRU    5
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..............      75.000
NO OF OCC ....................      1.940
NO OF POISSON MAG. ..........       3
SUM OF POISSON OCC. .........       1.940
DISTRIBUTION OF MAG.
        5.050        5.550        6.050
         .982         .478         .480
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE     6
----------------

RANDOM SOURCES SEGMENT 1
NUMBER OF BANDS: 1   BOUNDARY COND:    0    0    0    0   ELEMENTS: 16 THRU   16
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE ..............      75.000
NO OF OCC ....................     61.699
NO OF POISSON MAG. ..........       4
SUM OF POISSON OCC. .........      61.699
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550         .050
       48.108       11.861        1.421         .256         .049
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

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AREA SOURCE 17
--------------

RANDOM SOURCE SEGMENT .
NUMBER of BANDS: 1    BOUNDARY COND:    o    0    u    0    ELEMENTS: 17 THRU 17
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIMEDATABASE.............    75.000
NO or OCC.................    10 J. III
NO OF POISSONMAG..........    5
SUM OF POISSON OCC.........    103. IOO
oISIRI. II IION OF MAG.
      5.050       5.550       6.050       6.550       7.050
     67.396      19.822       2.378        .431        .091
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE 18
--------------

RANDOM SOURCE SEGMENT 3
NUMBER OF BANDS: 1    BOUNDARY COND:    1    o    0    0    ELEMENTS: 18 THRU 18
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIMEDATABASE.............    75.000
NO OF OCC.................    122.295
NO OF POISSON MAG.........    s
SUM of POISSON OCC.........    32.295
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050
      8.356      23.510       2.021        .512        .096
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE 19
--------------

RANDOM SOURCE SEGMENT 5
NUMBER OF BANDS: 1    BOUNDARY COND:    o    0    u    1    ELEMENTS: 19 THRU 19
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIMEDATABASE.............    75.000
NO OF OCC.................    60.595
NO OF POISSONMAG..........    5
SUM OF POISSON OCC.........    60.596
DISTRIBUTION OF RAG.
      5.050       5.550       6.050       6.550       7.050
     47.247      11.649       1.598        .254        .048
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE 20
--------------

RANDOM SOURCE SEGMENT 6
NUMBER OF BANDS: 1    BOUNDARY COND:    o    0    0    1    ELEMENTS: 20 THRU 20
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIMEDATABASE.............    75.000
NO OF OCC.................    104.627
NO of POISSONMAG..........    5
SUM OF POISSON OCC.........    104.627
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050
     81.580      20.114       2.413        .436        .082
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
AREA SOURCE . 1
. ------------ --

RANDOM SOURCE SEGMENT 7
NUMBER of BANDS: 1    BOUNDARY COND:     u     u     u     u    ELEMENTS: 21 THRU 21
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE . . . . . . . . . . . .     75.000
NO of OCC . . . . . . . . . . . . . . .   255.494
NO of POISSON MAG . . . . . . . . . .*.     5
SUM OF POISSON OCC. . . . . . . . .       255.493
DISTRIBUTION of MAG.
        5.050        5.550        6 .050        6.550        7.050
      199.214       49.116        5.893        1 .06.9         .201
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA  SOURCE  :2
----------------

RANDOM SOURCES SEGMENT 8
NUMBER Of BANDS: 1    BOUNDARY COND:     1     o     u     o    ELEMENTS: 22 THRU 22
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE . . . . . . . . . . . .     75.000
NO of orc . . . . . . . . . . . . . . .   155.696
NO Of POISSON MAG. . . . . . . . . .       5
SUM OF POISSON OCC. . . . . . . . .       155.698
DISTRIBUTION Or MAG.
        5.050        5.550        6.050        6.550        7.050
      121.461       29.932        3.591         .651         .123
THERE IS  N O  SEMI-MARKOV INPUT FOR THIS SOURCE

AREA  SOURCE  23
----------------

SHUMAGIN SOURCE
NUMBER of BANDS: 1    BOUNDARY COND:     1     1     0     0    ELEMENTS: 23 THRU  23
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE . . . . . . . . . . . .     75.('00
No Of OCC . . . . . . . . . . . . . . .   22.789
NO OF POISSON MAG. . . . . . . . . .       6
SUM OF POISSON OCC. . . . . . . .         22.790
DISTRIBUTION Of MAG.
        5.050        5.550        6.050        6.550        7.050        ?.550
      13.739        5.457        2.183         .851         .514         .046
THERE IS  N O  SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE   24
---- ---- ------ --

SHUMAGIN SEG
NUMBER OF BANDS : 1    BOUNDARY COND:     1     1     1     o    ELEMENTS: 24 THRU  24
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE . . . . . . . . . . . .     75.000
NO or OCC . . . . . . . . . . . . . . .   56.546
NO Of POISSON MAG. . . . . . . . . .       6
SUM Of POISSON OCC. . . . . . . . .       46.436
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050        7.550
      34.090        3.431        5.*it.       2.111        1.274         .114
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT 17
FILED INFORMATION -
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
IDKEY.....SHUMAGINSEG
NUMBER OF MAGNITUDES.......      3
MAGNITUDE INCREMENT.......       .5000
FIRSTS-M MAGNITUDE.......      8.0500
PERIOD OF INTEREST.........   40.00
                    NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE        0          1          2          3          4          5          6          7          8
-----------------  --------   --------   --------   --------   --------   --------   --------   --------   --------
      8.050        .8788585   .0719999   .0311855   .0121350   .0041888   .0012538   .0003123   .0000595   .0000069
      8.550        .9318633   .0547676   .0116829   .0019482   .0002957   .0000380   .0000040   .0000003
      9.050        .9758666   .0240347   .0000986   .0000002

AREA  SOURCE  25
----------------

SEMIDI
NUMBER OF BANDS:1   BOUNDARY COND:    1    1    1    1    ELEMENTS: 25 THRU 25
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIME DATABASE.............     15.000
NO OF OCC..................    55.588
NO OF POISSON MAG..........     6
SUM OF POISSON OCC.........    55.587
DISTRIBUTION OF HAL.
      5.050       5.550       6.050       6.550       7.050       7.550
     33.512      13.311       5.329       2.075       1.253        .11.?
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT 17
FILED INFO HP A110N -
IDKEY.....SEMIDI
NUMBER OF MAGNITUDES.......      3
MAGNITUDE INCREMENT........       .5000
FIRSTS-M MAGNITUDE.........    0.05011
PERIOD OF INTEREST.........   40.00
                    NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE        0          1          2          3          4          5          6          7          8
-----------------  --------   --------   --------   --------   --------   --------   --------   --------   --------
      8.050        .8228836   .1051228   .0456769   .017 7876  .0061375   .0018362   .0004577   .0000875   .0000102
      8.550        .8966504   .0840819   .0161281   .002 6962  .0003903   .0000480   .0000048   .0000004
      9.050        .9679829   .0318976   .0001 194  .0000002

AREA SOURCE   26
----------------

PCH SEG 1
NUMBER OF BANDS:  1   BOUNDARY COND:    1    1    1    0    ELEMENTS: 26 THRU 26
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE    1
TIME DATABASE.............    75.000
NO of OCC..................   61.677
No of POISSON MAG..........     6
SUM OF POISSON OCC.........   61.678
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       7.550
     49.241      19.559       7.823       3.049       1.841        .165
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT  17
FILED INFORMATION -
IDKEY.....PCHSEG 1
NUMBER OF MAGNITUDES.......      3
MAGNITUDE INCREMENT........       .5000
FIRSTS-M MAGNITUDE.........    6.0500
PERIOD OF INTEREST.........   40.00
                    NUMBER OF EARTHQUAKES
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
DISCRETE MAGNITUDE          0          1          2          3          4          5          6          7          8
------------------      --------   --------   --------   --------   --------   --------   --------   --------   --------
      8.050             .9390654   .0356775   .0158150   .0063059   .0022332   .0006812   .0001766   .0000350   .0000043
      8.550             .9705261   .0248979   .0039337   .0005607   .0000710   .0000078   .0000007
      9.050             .9922402   .0077404   .0000194

AREA SOURCE    27
-----------  -----

PCR SEC 2
NUMBER OF BANDS: 1    BOUNDARY COND:    1    1    1    1    ELEMENTS: 27 THRU 27
NUMBER OF ELEMENTS IN [ A C M  BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE . . . . . . . . . . . . .     75.000
NO OF OCC . . . . . . . . . . . . . . . .    80.719
NO OF POISSON MAG. . . . . . . . . . . .      6
SUM OF POISSON OCC. . . . . . . . . . .      80.726
DIS?RIEUI1ON OF MAG.
      5.050       5.550       6.050       6.550       1.050       7.550
     48.664      19.329       7.732       3.013       1.819        .163
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT 17
FILED INFORMATION
IDKEY. . . . . . . . . . . . . . . . . . . . . . PCRSEG 2
NUMBER OF MAGNITUDES . . . . . . . . .      3
MAGNITUDE INCREMENT . . . . . . . . . .      .5000
FIRSTS-M MAGNITUDE . . . . . . . . . .      6.0500
PERIOD OF INTEREST . . . . . . . . . .     40.00
                        NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE          0          1          2          3          4          5          6          7          11
------------------      --------   --------   --------   --------   --------   --------   --------   --------   --------
      8.050             .9434148   .0338430   .0145021   .0055861   .0019120   .0005694   .0001420   .0000274   .0000033
      8.550             .9814665   .0157449   .0024095   .0003332   .00004 10  .0000044   .0000004
      9.050             .9947117   .0052767   .0000116

AREA SOURCE    2P
----------------

PCR SEGMENT 3
NUMBER OF BANDS: 1    BOUNDARY COND:    1    1    1    1    ELEMENTS: 28 THRU 28
NUMBER OF ELEMENTS IN EACH B A N O  STARTING WITH DEEPEST ONE     1
TIME DATA BASE . . . . . . . . . . . . .     75.000
NO OF OCC . . . . . . . . . . . . . . . .    76.247
NO OF POISSON MAG. . . . . . . . . . . .      6
SUM OF POISSON OCC. . . . . . . . . . .      76.246
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       1.050       7.550
     45.967      18.258       7.303       2.846       1.718        .154
THE   NEXT 3 MAGNITUDES  A R E  SEMI-MARKOV. INPUT IS READ FROM UNIT 17
FILED INFORMATION  -
10 KEY. . . . . . . . . . . . . . . . . . . . . . PCRSEGMENT
NUMBER OF MAGNITUDES . . . . . . . . .      3
MAGNITUDE INCREMENT . . . . . . . . . .      .5000
FIRSTS-M MAGNITUDE . . . . . . . . . .      6.0500
PERIOD OF INTEREST . . . . . . . . . .     40.00
                        NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE          0          1          2          3          4          5          6          7          8
------------------      --------   --------   --------   --------   --------   --------   --------   --------   --------
      8 .050            .9467484   .0324614   .0134659   .0050268   .0016688   .0004829   .0001173   .0000?21   .0000026
      8.550             .9873218   .0108219   .0016107   .0002167   .0000260   .0000027   .0000002
      9.050             .9961791   .0038134   .0000075
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
AREA SOURCE . 9
------ -------- --

YAKATAGA GAP
NUMBER OF BANDS : 1   BOUNDARY COND:    1    1    1    1   ELEMENTS: 29 THRU  29
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE .............        75.000
NO OF OCC ..............0.        25.516
NO OF POISSON MAG. .........        b
SUM OF POISSON OCC. ........        26.517
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       7.550
     15.986       b.350       2.540        .990        .598        .053
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT   17
FILED INFORMATION -
IDKEY.......................YAKATAGA GAP
NUMBER OF MAGNITUDES........      3
MAGNITUDE INCREMENT.........       .5000
FIRST S-M MAGNITUDE.........      8.0500
PERIOD OF INTEREST..........     40.00
                         NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE        o          1          2          3          4          5          b          7          b
------------------     -------- -------  ----- ---  -- ------ -------- --------  --------  --------  --------
      8.050            .9224209  .0402779  .0211992  .0099761  .0041319  .0014665  .0004252  .0000913  .0000111
      8.550            .8805026  .0895289  .0235190  .0052644  .0010020  .0001598  .0000205  .0000019  .0000001
      9.050            .9417091  .0572016  .0010447  .0000046

AREA SOURCE    30
------ ------ ----

YAKUTAT GAP
NUMBER OF BANDS: 1    BOUNDARY COND:    1    1    1    0   ELEMENTS: 30 THRU  30
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATABASE .............        75.000
No of OCC..................         2.112
NO OF POISSON MAG..........        b
SUM OF POISSON OCC.........       201.907
DISTRIBUTION 01 MAG.
      5.050       5.550       6.050       6.550       7.050       1.5511
    120.726      48.807      19.523       7.847       4.594        .411
THE NEXT 3 MAGNITUDES ARE SEMI-MARKOV. INPUT IS READ FROM UNIT 17
FILED INFORMATION -
in  KLV ....................YAKUTAT GAP
NUMBER OF MAGNITUDES........      3
MAGNITUDE INCREMENT.........       .50011
FIRST S-M MAGNITUDE.........      8.0500
PERIOD OF INTEREST..........     40.00
                         NUMBER OF EARTHQUAKES
DISCRETE MAGNITUDE        o          1          2          3          4          5          b          1          8
------- ------ -- --    ------ ------ ----  ----- --- ---- ---- ------ --  ------ --  ------ -  ------ --  ------ -
      9.050            .9914666  .00>0913  .0021671  .0008486  .000292?  .0000875  .0000217  .0000041  .0000004
      8.550            .S'852123  .0118367  .0024339  .0004371  .0000680  .0000090  .0000010
      9.050            .9973885  .0025985  .0000129

AREA SOURCE 31
----------------

DEEP BENIOFF ZONE SEGMENT  1
NUMBER OF BANDS : 1   BOUNDARY COND:    1    o    1    u   ELEMENTS: 31 THRU  31
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
TIME DATA BASE . . . . . . . . . . . . .      75.000
NO OF OCC . . . . . . . . . . . . . . . .     14.658
No OF POISSON MAG. . . . . . . . . . .         6
SUM OF POISSON OCC. . . . . . . . .           144.659
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050        7.550
        6.602        3.668        1.956        1.076        1.339         .018
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

                                  P
AREA  SOURCE  32
----------------

OF EPBENIOFF ZONE SEGMENT 2
NUMBER OF BANDS: 1    BOUNDARY COND:    1    0    0    0    ELEMENTS: 32 THRU 32
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE . . . . . . . . . . . . .      75.000
NO OF OCC . . . . . . . . . . . . . . . .     21. 763
NO OF  POISSON  MAG. . . . . . . . . .         b
SUM OF POISSON OCC. . . . . . . . .           21.762
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050        7.550
        9.801        5.445        2.904        1.597        1.988         .021
THERE IS  N O  SEMI-MARKOV INPUT FOR THIS SOURCE

AREA  SOURCE  33
----------------

DEEP BENIOFF ZONE SEGMENT 3
NUMBER OF BANDS: 1    BOUNDARY COND:    1    u    o    0    ELEMENTS: 33 THRU 33
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE . . . . . . . . . . . . .      75.000
NO OF OCC . . . . . . . . . . . . . . . .     18.435
NO OF POISSON MAG. . . . . . . . . . .         b
SUM OF POISSON OCC. . . . . . . . .           18.744
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        1.050        7.550
        8.303        4.613        2.460        1.353        1.988         .02?
THERE IS  NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE    34
----------------

DEEP BENIOFF ZONE SEGMENT 4
NUMBER OF BANDS: 1    BOUNDARY COND:    1    0    0    0    ELEMENTS:  34 THRU  34
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIME DATA BASE . . . . . . . . . . . . .      75.000
NO OF OCC . . . . . . . . . . . . . . . .     22.932
NO OF POISSON MAG. . . . . . . . . .          b
SUM OF POISSON OCC. . . . . . . . .           22.933
DISTRIBUTION OF MAG.
        5.050        5.550        6.050        6.550        7.050        7.550
       10.328        5.738        3.060        1.683        2.095         .029
THERE IS  N O  SEMI-MARKOV INPUT FOR THIS SOURCE

AREA  SOURCE  35
----------------

DEEP BENIOFF ZONE SEGMENT 5
NUMBER OF BANDS: 1    BOUNDARY COND:    1    u    0    0    ELEMENTS: 35 THRU  3 5
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST  O N L     1
```

Fig. A-10 - SEISMICEXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
TIMEDATABASE.............      75.000
NO OF OCC................      38.221
NO OF POISSONMAG.........       b
SUM OF POISSON OCC.......      38.221
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       7.550
     17.213       9.563       5.100       2.805       3.492        .048
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE    26
---------------

DEEP BENIOFF ZONE SEGMENT  6
NUMBER OF BANDS: 1   BOUNDARY COND:    1    0    0    0   ELEMENTS: 36 THRU 36
NUMBER OF ELEMENTS IN L. ACM BAND STARTING WITH DEEPEST ONE     1
TIMEDATABASE.............      75.000
NO OF OCC................      27.159
NO OF POISSONMAG.........       b
SUM OF POISSON OCC.......      27.158
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       7.550
     12.231       6.795       3.624       1.993       2.481        .034
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

AREA SOURCE    27
--------- ---- ---

ILIAMNA ZONE
NUMBER OF BANDS: 1   BOUNDARY COND:    1    0    0    0   ELEMENTS: 31 THRU 31
NUMBER OF ELEMENTS IN EACH BAND STARTING WITH DEEPEST ONE     1
TIMEDATABASE.............      75.000
NO OF OCC................      27.696
NO OF POISSONMAG.........       b
SUM OF POISSON OCC.......      27.695
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       7.550
     12.474       6.930       3.696       2.033       2.531        .035
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

LINE SOURCE     1
----- ------ -----

CASTLE MOUNTAIN FAULT
    1  SEGMENTS   BOUNDARY CONDITION    0    0  STARTING AT NODE   44   RENUMBERED   44
TIMEDATABASE.............      75.000
NO OF OCC................       6.190
NO OF POISSONMAG.........       b
SUM OF POISSON OCC.......       7.500
DISTRIBUTION OF MAG.
      5.050       5.550       6.050       6.550       7.050       1.550
      4.374       1.814        .812        .314        .156        .030
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

LINE SOURCE     2
------ ----- -----

DENALI
      SEGMENTS   BOUNDARY CONDITION    0    0  STARTING AT NODE   46   RENUMBERED   46
TIME DATA BASE...........      75.000
NO OF OCC................      30.946
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
NO OF POISSON MAG. .........        7
SUM OF POISSON OCC. ........      37.751
DISTRIBUTION OF PA G.
      5.050       5.550       6.050       6.550       7.050       7.550       8.050
     1.870       4.070       4.060       1.570        .778        .253        .150
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

LINE SOURCE      3
-------------  ---

CHATHAM STRAIT
    4  SEGMENTS   BOUNDARY CONDITION    0    0  STARTING AT NODE   49   RENUMBERED   49
TIME DATA BASE ............      75.000
NO OF OCC ..................     15.470
NO OF POISSON MAG. .........      b
SUM OF POISSON OCC. ........     18.685
DISTRIBUTION of MAG.
      5.050       5.550       6.050       6.550       1.050       1.550
     10.940       4.530       2.030        .783        .389        .013
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOURCE

LINE SOURCE      4
----------------

FAIRWEATHER
    3  SEGMENTS   BOUNDARY COND II ION  0    0  STARTING AT NODE   54   RENUMBERED   54
TIME DATA BASE ............     75.000
NO OF OF C .................    247.500
NO OF POISSON PAC. .........       7
SUM OF POISSON OCC. ........    501.920
DISTRIBUTION OF M A C.
      5.050       5.550       6.050       6.550       1.050       7.550       8.050
    174.980      72.530      32.480      12.530       6.225       2.025       1.200
THERE IS NO SEMI-MARKOV INPUT FOR THIS SOUR CE

ATTENUATION RELATIONSHIPS

ACCEL    CM/SEC/SEC          IC=    *0.(100        MN=   100.000        MX=  150 0.000
          B1          B2          B3          B4        LN SIG        MG MX
     19E.670        .823        .000       1.561         .568         .000
     21E.000       .5110        .000        .850         .606         .000

VELOCITY  CM/SEC          IC=     2.000        MN=    10.000        MX=   100.000
          B1          B2          B3          B4        LN SIG        MG MX
        .836       1.220        .000       1.430         .652         .000
       5.330        .720        .000       1.650         .666         .000

PSA  C.P SEC SS           IC=     4.000        MN=    30.000        MX=   200.000
          B1          B2          B3          B4        LN SIG        MG MX
        .317       1.520        .000       1.510         .811        6.500
       6.130       1.060
       5.260        .781        .000       1.050         .621         .000

C1                   .864
C2                   .463
DEPTH              -6. 000

LOG-NORMAL DISTRIBUTION ON ATTENUATION
NO OF STD ON EACH SIDE OF MEAN      3.0
NO OF INCREMENTS IN DIST             85
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
INTG. STEP VERT. (KM)          15.000
INTG. STEP HOR.  (KM)          15.000
EPSILON          (KM)            .100

SOURCE/MAGNITUDE CONTRIBUTION TABLE INFORMATION
------------------------------------------------

INPUT SPECIFIES TABLES ARE TO BE GENERATED FOR EVERY  1 INCREMENTS UP TO INCREMENT  1 FOR THESE PARAMETERS
  1

PARAMETER TABLE SIZE (SUM OF MAGNITUDES ACROSS ALL SOURCES) =  241

PARAMETER      MI MI HUH     MAXIMUM     INCREMENT   FIRST TABLE   LAST TABLE   FIRST LEVEL   LAST LEVEL    ADDRESS
---------      ---------     --------    ---------   -----------   ----------   -----------   ----------    -------
   1            100.000      1500.000      40.000       120.000      120.000          4             4           0

TABLE SPACE AVAILABLE  -     10800
TABLE SPACE USED               241

HORIZONTAL RUPTURE LENGTHS (KM)
      5.050       5.550       6.050       6.550       7.050       7.550       8.050       8.550       9.050
      2.700       4.700       8.400      15.000      27.000      47.000      90.000     160.000     225.000

DOWN DIP RUPTURE LENGTHS(KM)
      5.050       5.550       6.050       6.550       7.050       7.550       8.050       8.550       9.050
      2.700       4.700       8.400      15.000      27.000      47.000      50.000      10.000      80.000

THE CONSTANT C = C1 * EXP(C2*M) IN ATTENUATION EQUATION
   8.9378      11.264      14.195      17.889      22.545      28.412      35.805      44.091      * 0.091

PARAMETER 1 - ACCEL   CM/SEC/SEC

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   9.4082      9.8199      10.232      10.643      11.055      11.467      11.878      12.249      12.249

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   7.8721      8.1221      8.3721      8.6221      8.8721      9.1221      9.3721      9.5971      9.5971

PARAMETER 2 - VELOCITY  CM/SEC

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   5.9619      6.5919      7.2019      7.8119      8.4219      9.0319      9.6419      10.191      10.191

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   5.3094      5.6694      6.0294      6.3894      6.7494      7.1094      7.4694      7.7934      7.7934

PARAMETER 3 - PSV  0.8 SECS

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   6.5271      7.2871      8.0471      8.7562      9.2862      9.8162      10.346      10.823      10.823

ATTENUATION COEFFICIENT B1 * EXP(B2 * M)
   5.6142      5.9947      6.3752      6.7757      7.1662      7.5567      7.9472      8.2986      8.2986

*** ELEMENT GEOMETRY WARNINGS FOR AREA SOURCE 9
    DIMENSIONS - TOP:  133.2     BOTTOM:  225.6     DOWN-DIP LEFT:   29.0     DOWN-DIP RIGHT:   28.2
    A HORIZONTAL LENGTH OR A DOWN-DIP LENGTH OF THE ELEMENT IS BELOW THE RECOMMENDED LIMIT OF TWO INCREMENTS.

*** SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 23
    SOURCE DIMENSIONS - LEFT:  123.5     RIGHT:  116.5     DOWN-DIP LENGTH:  116.4
    WIDTH OF EACH LEVEL FROM BOTTOM TO TOP:
```

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
    1      171.2
    2      231.5
  BOUNDARY CONDITION • 1 IS IN EFFECT FOR TOP OF SOURCE.

• 0 * SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 24
  SOURCE DIMENSIONS - LEFT:  265.4      RIGHT:  209.5      DOWN-DIP LENGTH:  204.2
  WIDTH OF EACH LEVEL FROM BOTTOM TO TOP:
    1      253.5
    2      269. %
  BOUNDARY CONDITION • 1 IS IN EFFECT FOR TOP Of SOURCE.

• *o SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 25
  SOURCE DIMENSIONS LEFT:  23*. 8      RIGHT:  238.0      DOWN-DIP LENGTH:  234.7
  WIDTH OF EACH LEVEL FROM BOTTOM TO TOP:
    1      215.9
    2      230.7
  BOUNDARY CL, NC II ION • 1 IS IN EFFECT FOR 10P OF SOURCE.
  MAGNITUDE 9.05          RUPTURE DIMENSIONS - HORIZONTAL:  225.0      DOWN-DIP:    15.0
  HORIZONTAL OR DOWN-DIP LENGTH OF SOURCE IS BELOW RECOMMENDED LIMIT FOR GIVEN BOUNDARY CONDITIONS AND RUPTURE DIMENSIONS.

*** SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 26
  SOURCE DIMENSIONS - LEFT:  249.1      RIGHT:  234.8      DOWN-DIP LENGTH:  23*.5
  WIDTH Of EACH LEVEL FROM BOTTOM 10 TOP:
    1      265.8
    2      371.1
  BOUNDARY CONDITION • 1 IS IN EFFECT FOR TOP Of SOURCE.

*** SOURCE GEOMETRY WARNINGS FOR AREA 50 URCE 27
  SOURCE DIMENSIONS - LEFT:  356.4      RIGHT:  300.6      DOWN-DIP LENGTH:  291.2
  WIDTH or EACH LEVEL FROM BOTTOM TO TOP:
    1      324.6
    2      197.5
  BOUNDARY CLNOII1ON • 1 IS IN EFFECT FOR TOP OF SOURCE.
  MAGNITUDE 9.05          RUPTURE OJH[NS1ONS - HORIZONTAL:  225.0      DOWN-DIP:    15.0
  HORIZONTAL On DOWN-DIP LENGTH OF SOURCE 1 S BELOW RECOMMENDED LIMIT FOR GIVEN BOUNDARY CONDITIONS AND RUPTURE DIMENSIONS.

• - o SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 26
  SOURCE DIMENSIONS - LEFT:  355.5      RIGHT:  356.4      DOWN-DIP LENGTH:  355.5
  WIDTH OF EACH LEVEL FROM OOI1ON 10 TOP:
    1      211.2
    2      192.1
  BOUNDARY C(,MO1I1ON • ] IS IN EFFECT FOR 10P OF SOURCE.
  MAGNITUDE 9.05          RUPTURE DIMENSIONS - HORIZONTAL:  225.0      DOWN-DIP:    15.0
  HORIZONTAL OR DOWN-DIP LENGTH Of SOURCE IS BELOW RECOMMENDED LIMIT FOR GIVEN BOUNDARY CONDITIONS AND RUPTURE DIMENSIONS.

• ** SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 29
  SOURCE DIMENSIONS - LEFT:  170.8      RIGHT:  132.0      DOWN-DIP LENGTH:    16.3
  WIDTH Of EACH LEVEL FROM BOI1OFI TO TOP:
    1      323.8
    .      366.9
  BOUNDARY CONDITION • 1 1S IN EFFECT FOR TOP Of SOURCE.

*** SOURCE GEOMETRY WARNINGS FOR AREA SOURCE 30
  SOURCE DIMENSIONS - LEFT:  363.9      RIGHT:  279.%      DOWN-DIP LENGTH:  153.7
  WIDTH OF EACH LEVEL FROM BOTTOM TO TOP:
    1      366.9
    2      403.8
  BOUNDARY CONDITION *1 IS IN EFFECT FOR TOP OF SOURCE.
```

PROBABILITY OF ZERO OCCURANCE PER INCREMENT — PART 1

MAG :	AREA SOURCE 1	AREA SOURCE 2	AREA SOURCE 3	AREA SOURCE 4	AREA SOURCE 5	hula SOURCE 6	AREA SOURCE 7	AREA SOURCE 8	AREA SOURCE 9	AREA SOURCE 10
5.05 :	.963865	.964039	.964026	.963516	.963453	.963717	.963832	.963874	.198670	.990059
5.55 :	.983995	.984242	.984181	.963892	.983810	.983994	.984064	.984065	.566097	.973533
6.05 :	.993228	.993359	.993334	.993182	.993144	.993239	.991213	.993267	.830760	.900941
6.55 :	.997349	.997411	.997362	.997328	.997315	.997342	.997363	.997362	.942248	.995584
7.05 :	.998203	.998233	.998233	.998192	.998174	.998204	.V98?1O	.998213	.995906	.998211
7.55 :	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
8.05 :	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.0[0000
8.55 :	.000000	.000000	.000000	.000000	.000000	.00 0000	.000000	.000000	.000000	.000000
9.05 :	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.0[0000

PROBAB ILITY OF ZERO OCCUR ANCE PER INCREMENT — PART 2

MAG :	AREA SOURCE 11	AREA SOURCE 12	AREA SOURCE 13	AREA SOURCE 14	AREA SOURCE 15	AREA SOURCE 16	AREA SOURCE 17	AREA SOURCE 18	AREA SOURCE 19	AREA SOURCE 20
5.05 :	.939658	.939913	.995855	.995849	.995930	.897766	.897680	.974214	.897638	.897697
5.55 :	.973350	.973553	.997643	.997839	.997942	.970274	.970211	.903293	.970236	.910215
6.05 :	.908097	.988984	.9* 781,	.991010	.997934	.996233	.996222	.986079	.996227	.996223
6.55 :	.995577	.995601	.000000	.000000	.000000	.999312	.999311	.997414	.999310	.9*931O
7.05 :	.998193	.996204	.000000	.000000	.000000	.999869	.999070	.999513	.999869	.V*9810
7.55 :	.000000	.000000	.000000	.000(500	.000000	.000000	.000000	.000000	.000000	.0[0000
8.05 :	.000000	.000000	.000000	.000000	.000000	.000000	.00 0000	.000000	●OOOWJO	.000000
8.55 :	.000000	.000000	.000000	.000000	.000000	.000000	.00 0000	.000000	.000000	.000000
9.05 :	.000000	.000000	.000000	.000000	.000000	.000000	.00 0000	.00 0000	.000000	.000000

PROBABILITY OF ZER O OCCURANCE PER INCREMENT — PARI 3

MAG :	AREA SOURCE 21	AREA SOURCE 22	AREA SOURCE 23	AREA SOURCE 24	AREA SOURCE 25	AREA SOURCE 26	AREA SOURCE 27	AREA SOURCE 28	AREA SOURCE 29	AREA SOURCE 30
5.05 :	.897649	.897670	.936425	.924377	.935131	.935711	.935622	.935530	.941264	.957942
5.55 :	.970169	.970109	.972.19	.990888	.971831	.971800	.971762	.971723	.974350	.9S9090
6.05 :	.996215	.996218	.988419	.985803	.988240	.988722	.986205	.988190	.989311	.959626
6.55 :	.999309	.999310	.995466	.994344	.995332	.995325	.99>319	.995312	.995761	.959847
7.05 :	.999870	.999869	.997213	.996567	.997168	.997164	.991160	.997157	.997428	.9S9910
7.55 :	.000000	.000000	.999749	.999690	.999745	.999744	.999744	.9997*3	.999768	.9s9992
8.05 :	.000000	.000000	.000000	.999490	.999240	.999822	.999832	.999833	.999338	.959970
8.55 :	.000000	.000000	.000000	.999713	.999556	.999914	.9999*5	.999960	.998980	.959948
9.05 :	.000000	.000000	.000000	.999898	.999863	.999971	.999984	.999988	.999502	.959991

PROBABILITY OF ZERO OCCURANCE PER IN CR EMENT — PAR I 4

MAG :	AREA SOURCE 31	AREA SOURCE 32	AREA SOURCE 33	AREA SOURCE 34	AREA SOURCE 35	AREA SOURCE 36	AREA SOURCE 37	LINE SOURCE 1	LINE SOURCE 2	LINE SOURCE 3
5.05 :	.967276	.967804	.960197	.967688	.965433	.963405	.878803	.899499	.00S550	.926641
5.55 :	.980906	.981193	.981443	.981121	.979891	.978592	.927807	.954316	.908090	.966680
6.05 :	.989506	.989654	.989601	.989615	.988926	.988213	.954797	.978750	.956476	.984473
6.55 :	.994135	.990216	.994300	.994193	.993805	.993407	.977371	.991620	.982670	.9S3080
7.05 :	.992736	.992836	.991701	.992807	.992321	.991834	.972023	.9V501O	.991331	.996944
7.55 :	.999900	.999900	.999884	.999899	.999892	.999885	.999602	.999190	.997163	.999899
8.05 :	.000000	.000000	.000000	●OOUOOO	.000000	.000000	.000000	.000000	.998316	.000000
8.55 :	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000
9.05 :	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000	.000000

Fig. A- 0 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

PROBABILITY OF ZERO OCCURRANCE PER INCREMENT PART 5

MAG :	LINE SOURCE 4
5.05 :	.367612
5.55 :	.639368
6.05 :	.813160
6.55 :	.922077
7.05 :	.960290
7.55 :	.986858
8.05 :	.992166
8.55 :	.000000
9.05 :	.000000

****** PROBABILITY OF AT LEAST ONE EXCEEDENCE IN 40.00 YEARS ******

NOAA SEISMIC EXPOSURE MAPS--GULF OF ALASKA --OCT--1981
MARKOV INPUT USED
SEISMIC EXSPOSURE MAP GROUND MOTION VALUES--GULF OF ALASKA-OCT--1981

ACCEL CM/SEC/SEC

INC : 40.000
MIN : 160.000
MAX : 500.000

S E COORDINATES X,Y,Z -152.455 54.000 .000 693.509 169.154

.00000	40.00000	80.00000	120.00000	60.00000	200.00000	240.00000	280.00000	320.00000	360.00000
.00000	1.00000	.99998	.92157	.53774	.29054	.13503	.06825	.03979	.02281
.00	.00	.00	16.22	52.34	117.03	276.25	566.35	985.60	1734.18
400.00000	440.00000	480.00000	520.00000	560.00000	600.00000	640.00000	680.00000	720.00000	760.00000
.01273	.00843	.00545	.00345	.00215	.00129	.00099	.00074	.00041	.00025
3122.60	4726.59	7321.99	11568.35	8[illegible]	30957.98	.00	.00	.00	.00
600.00000	840.00000	880.00000	920.00000	960.00000	000.00000	1040.00000	080.00000	1120.00000	60.00000
.00020	.00009	.00005	.00003	.00002	.00001	.00001	.00000	.00000	.00000
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
1200.00000	240.00000	12[illegible].00000	[illegible]2[illegible].00000	[illegible].00000	400.00000	440.00000	480.00000	1520.00000	560.00000
.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

PARAMETER 1 : ACCEL CM/SEC/SEC = 120.00 MAGNITUDE/SOURCE PERCENTAGE CONTRIBUTION TABLE PART 1

MAG :	AREA SOURCE 1	AREA SOURCE 2	AREA SOURCE 3	AREA SOURCE 4	AREA SOURCE 5	AREA SOURCE 6	AREA SOURCE 7	AREA SOURCE 8	AREA SOURCE 9	AREA SOURCE 10
5.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
5.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
6.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
6.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
7.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
7.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
8.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
8.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
9.05 :	.0000	.0000	.04400	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SUMS :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000

PARAMETER 1 : ACCEL CM/SEC/SEC = 120.00 MAGNITUDE/SOURCE PERCENTAGE CONTRIBUTION TABLE PART 2

MAG :	AREA SOURCE 11	AREA SOURCE 12	AREA SOURCE 13	AREA SOURCE 14	AREA SOURCE 15	AREA SOURCE 16	AREA SOURCE 17	AREA SOURCE 18	AREA SOURCE 19	AREA SOURCE 20
5.05 :	.0000	.0000	.2358	2.3082	.0000	.0000	.0000	.0000	.0000	.0000
5.55 :	.0000	.0000	.3076	2.1303	.0000	.0000	.0000	.0000	.0000	.0000
6.05 :	.0000	.0000	.7042	3.5261	.0204	.0000	.0000	.0000	.0000	.0000
6.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
7.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
7.55 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
8.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
8.55 :	.0000	.3000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
9.05 :	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SUMS :	.0000	.0000	1.2476	7.9646	.0204	.0000	.0000	.0000	.0000	.0000

PARAMETER 1 : ACCEL CM/SEC/SEC = 120.00 MAGNITUDE/SOURCE PERCENTAGE CONTRIBUTION TABLE PART 3

MAG :	AREA SOURCE 21	AREA SOURCE 22	AREA SOURCE 23	AREA SOURCE 24	AREA SOURCE 25	AREA SOURCE 26	AREA SOURCE 27	AREA SOURCE 28	AREA SOURCE 29	AREA SOURCE 30
5.05 :	.0000	.0000	.0000	.7047	6.6589	3.7799	.0000	.0000	.0000	.0000
5.55 :	.0000	.0000	.0000	.3811	6.9089	4.7109	.1652	.0000	.0000	.0000
6.05 :	.0000	.0000	.0478	1.6181	6.1988	[illegible]	.5385	.0184	.0000	.0000
6.55 :	.0000	.0000	.1185	1.7091	4.8518	4.0633	.6815	.1816	.0047	.0042
7.05 :	.0000	.0000	.2134	2.3354	5.1884	4.8019	1.0951	.3505	.0563	.0089
7.55 :	.0000	.0000	.0422	.3841	.7412	.7510	.211	.0868	.0168	.0047
8.05 :	.0000	.0000	.0000	1.3103	4.0182	1.0929	.4389	.1978	.1896	.0220
8.55 :	.0000	.0000	.0000	.0000	2.5741	.5869	.1827	.0674	.4456	.0591
9.05 :	.0000	.01100	.0000	.0000	.7380	.1424	.0462	.0178	.1717	.0001
SUMS :	.0000	.0000	.4619	8.6429	37.8783	24.6480	3.3752	.9203	.8847	.1082

Fig. 2 SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

PARAMETER : ACCEL CM/SEC/SEC = 20.00 MAGNITUDE/SOURCE PERCENTAGE CONTRIBUTION TABLE PART 4

MAG	AREA SOURCE 31	AREA SOURCE 32	AREA SOURCE 33	AREA SOURCE 34	AREA SOURCE 35	AREA SOURCE 36	AREA SOURCE 37	LINE SOURCE 1	LINE SOURCE 2	LINE SOURCE 3
5.05	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
5.55	.0000	.0839	.2966	.2531	.0000	.0000	.0000	.0000	.0000	.0000
6.05	.0364	.2954	.5632	.4863	.1339	.0000	.1410	.0000	.0000	.0000
6.55	.1033	.4492	.6825	.6928	.3337	.0264	.1753	.0000	.0000	.0000
7.05	.4080	1.4909	2.5908	2.1644	1.2128	.2372	.6088	.0000	.0000	.0000
7.55	.0127	.0426	.0739	.0565	.0423	.0100	.0000	.0000	.0000	.0000
8.05	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
8.55	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
9.05	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
SUMS	.5604	.0362	4.1490	3.655.	1.7227	.2737	1.1251	.0000	.0000	.0000

PARAMETER : ACCEL CM/SEC/SEC 20.00 MAGNITUDE/SOURCE PERCENTAGE CONTRIBUTION TABLE PART 5

MAG	LINE SOURCE 4	ROWSUMS
5.05	.0000	13.6875
5.55	.0000	15.2397
6.05	.0000	19.2272
6.55	.0000	14.0781
7.05	.0000	22.9626
7.55	.0000	2.4939
8.05	.0000	7.2698
8.55	.0000	3.9163
9.05	.0000	1.1249
SUMS	.0000	.25455+001

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

PARAMETER 1 : ACCEL CM/SEC/SEC SUMMARY MAGNITUDE/SOURCE CONTRIBUTION TABLE PART 1

VALUE :	AREA SOURCE 1	AREA SOURCE 2	AREA SOURCE 3	AREA SOURCE 4	AREA SOURCE 5	AREA SOURCE 6	AREA SOURCE 7	AREA SOURCE 8	AREA SOURCE 9	AREA SOURCE 10
120.0:	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000

PARAMETER 1 : ACCEL CM/SEC/SEC SUMMARY MAGNITUDE/SOURCE CONTRIBUTION TABLE PART 2

VALUE :	AREA SOURCE 11	AREA SOURCE 12	AREA SOURCE 13	AREA SOURCE 14	AREA SOURCE 15	ARIA SOURCE 16	AREA SOURCE 17	AREA SOURCE 18	ARIA SOURCE 19	AREA SOURCE 20
120.0:	.00000	.00000	.31759-001	.20274+000	52OOLJ-OOJ	.00000	.00000	.00000	.00000	.00000

PARAMETER 1 : ACCEL CM/SEC/SEC SUMMARY MAGNITUDE/SOURCE CONTRIBUTION TABLE PART 3

VALUE :	AREA SOURCE 21	AREA SOURCE 22	AREA SOURCE 23	AREA SOURCE 24	AREA SOURCE 25	AREA SOURCE 26	ARCA SOURCE 27	AREA SOURCE 28	ANIA SOURCE 29	AREA SOURCE 30
120.0:	.00000	.00000	.11758-001	.22001+000	.96421.000	.62742+000	.05917-001	.23427-001	.22519-001	.2?s0?-002

PARAMETER 1 : ACCEL CM/SEC/SEC SUMMARY MAGNITUDE/SOURCE CONTRIBUTION TABLE PART 4

VALUE :	AREA SOURCE 31	AREA SOURCE 32	AREA SOURCE 33	AREA SOURCE 34	AREA SOURCE 35	AREA SOURCE 36	AREA SOURCE 37	LINE SOURCE 1	LINE SOURCE 2	LINE SOURCE 3
120.0:	.19265-001	.60126-001	.10562+000	.93041-001	.43852-001	.69660-002	.28640-001	.00000	.00000	.00000

PARAMETER 1 : ACCEL CM/SEC/SEC SUMMARY MAGNITUDE/SOURCE CONTRIBUTION TABLE PARI 5

VALUE :	LINE sourer 4	: ROWSUMS
120.0:	.00000	.25455+001

Fig. A-10 - SEISMIC EXPOSURE, Gulf of Alaska.
Output for a Single Site (continued).

```
******   P R O B A B I L I T Y   O F   A T   L E A S T   O N E   E X C E E D E N C E   I N   40.00   Y E A R S   ● *****

NOAA SEISMIC EXPOSURE MAPS--GULF OF ALASKA --OCT--1981
MARKOV INPUT USED
SEISMIC EXSPOSURE MAP GROUND MOTION VALUES--GULF OF ALASKA-OCT--1981
```

V E L O C I T Y C M / S E C

```
INC =      2.000
MIN =     10.000
MAX =    100.000
```

NOTE: No tables were generated for velocity

```
SITE COORDINATES X,Y,Z          -152.455    54.000      .000   693.509   169.154

      .00000     2.00000     4.00000     6.00000     ● .00000    10.00000    12.00000    14.00000    16.00000    18.00000
     1.00000      .99884      .83983      .53564      .30666      .16400      .09988      .06560      .04200      .02633
         .00       6.43       22.34       52.65      109.72      223.81      380.62      590.03      932.77     1499.72

    20.00000    22.00000    24.00000    26.00000    28.00000    30.00000    32.00000    34.00000    36.00000    38.00000
     .01899      .01349      .00944      .00648      .00435      .00354      .00233      .00187      .00149      .00118
    2386.83     2945.07     4218.07     6187.19     9184.11    11274.64    12125.87    21341.64    26885.88    33889.40

    40.00000    42.00000    44.00000    46.00000    48.00000    50.00000    52.00000    54.00000    56.00000    50.00000
     .00071      .00054      .0000 1     .00035      .00031      .00023      .00016      .00011      .00008      .00001
         .00        .110        .00         .00         .00         .00         .00         .00         .00         .00

    60.00000    62.00000    64.00000    66.00000    68.00000    10.00000    72.00000    74.00000    16.00000    78.00000
     .00005      .00003      .00002      .00002      .00001      .00001      .00000      .00000      .00000     ● .0000C
         .00         .00         .00         .00         .00         .00         .00         .00         .00         .00

    80.00000    82.00000    84.00000    86.00000    88.00000    90.00000    92.00000    94.00000    96.00000    98.00000
     .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000      .00000
         ● 00        .00         .00         .00         .00         .00         .00         .00         .00         .00
```

P S V 0 . 8 S E C S 3

```
INC =      4.000
MIN =     30.000
MAX =    200.000
```

NOTE: No tables were generated for PSV

```
SITE COORDINATES X,Y,Z          -152.455    54.000      .000   693.509   169.154

      .00000     4.00000     0.00000    12.00000    16.00000    20.00000    24.00000    28.00000    32.00000    36.00000
     1.00000      .91681      .64018      .38356      .72191      .14839      .10313      .06922      .(15208     .03225
         .00       16.59       39.64       83.18      155.15      249.52      367.99      558.10      748.35     1220.88

    40.00000    44.00000    48.00000    52.00000    56.00000    60.00000    64.00000    68.00000    72.00000    76.00000
     .02268      .01896      .01317      .0109U      .00741      .00609      .00493      .00396      .0031 7     .0025 3
    1744.27     2090.40     3018.78     3651.24     5378.87     6549.52     8090.8s    10072.38    12587.67    15771.60

    80.00000    84.00000    88.00000    92.00000    96.00000   100.00000   10*.00000   100.00000   112.00000   116.00000
     .00203      .00179      .00161      .00125      .00096      .00082      .00073      .0005s      .00045      .00041
   19719.61    22366.12    24829.84    31982.46         .00         .00         .00         .00         .00         .00

   120.00000   12*.00000   128.00000   132.00000   136.00000   140.00000   144.00000   148.00000   152.00000   156.00000
     .00035      .00029      .00021      .00016      .00014      .00010      .00010      .00009      .00007      .00006
         .00         .00         .00         .00         .00         .00         .00         .00         .00         .00

   160.00000   164.00000   168.00000   112.00000   176.00000   180.00000   184.00000   188.00000   192.00000   196.00000
     .00004      .00004      .00002      .00002      .00002      .00001      .00001      .00001      .00000      .0000[
         .00         .00         .00         .00         .00         .00         .00         .00         .00         .00
```

APPENDIX B

MARKOV
INPUT/OUTPUT SUMMARY

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		Page
B.1.0	SEMI-MARKOV PROGRAM INPUT/OUTPUT	B-1

List of Tables

B-1	Distribution of Holding Times for Semidi and PCK (Part 1) Gaps	B-2
B-2	Distribution of Holding Times for PCK (Part 2) Gap	B-2
B-3	Distribution of Holding Times for PCK (Part 3) Gap	B-3
B-4	Distribution of Holding Times for Yakataga Gap	B-3
B-5	Distribution of Holding Times for Yakutat Gap	B-4

List of Figures

B-1 Partial MARKOV Printed Output (for the Shumagin Gap Source Only)

B-2 Disk Output from MARKOV

B.1.0 SEMI-MARKOV PROGRAM INPUT/OUTPUT

Input to the MARKOV program is listed in Tables 1 through 8 and in Tables B-1 through B-5. Partial output is shown in Figure B-1.

TABLE B-1
DISTRIBUTION OF HOLDING TIMES FOR SEMIDI AND PCK
(PART 1) GAPS

Holding Time (Years)

	0.25 Fractile	0.5 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	58	86	115	322
t_{12}	63	92	127	345
$'_{13}$	69	98	138	368
t_{21}	92	132	178	472
$'_{22}$	100	144	190	506
t_{23}	108	155	201	541
$'_{31}$	127	173	207	552
t_{32}	138	189	230	575
t_{22}	150	196	253	598

TABLE B-2
DISTRIBUTION OF HOLDING TIMES FOR PCK
(PART 2) GAP

	Holding Time (Years)			
	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	72	107	143	400
t_{12}	79	114	157	429
$'_{13}$	86	122	172	458
t_{21}	114	164	222	586
$'_{22}$	124	179	236	629
t_{23}	134	193	250	672
$'_{31}$	157	215	257	687
t_{32}	172	229	286	715
$'_{33}$	186	243	315	744

TABLE B-3
DISTRIBUTION OF HOLDING TIMES FOR PCK
(PART 3) GAP

	Holding Time (Years)			
	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	88	131	175	490
t_{12}	96	140	193	525
t_{13}	105	149	210	560
t_{21}	140	201	271	718
t_{22}	152	219	289	770
t_{23}	165	236	306	823
t_{31}	193	263	315	840
t_{32}	210	280	350	875
t_{33}	228	298	385	910

TABLE B-4
DISTRIBUTION OF HOLDING TIMES FOR YAKATAGA GAP

	Holding Time (Years)			
	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	19	28	37	104
t_{12}	20	30	41	111
t_{13}	22	31	44	118
t_{21}	30	43	57	152
t_{22}	32	46	62	163
t_{23}	35	50	65	174
t_{31}	41	56	67	178
t_{32}	44	59	74	183
t_{33}	48	63	81	192

TABLE B-5
DISTRIBUTION OF HOLDING TIMES FOR YAKUTAT GAP

	Holding Time (Years)			
	0.25 Fractile	0.50 Fractile	0.75 Fractile	1.0 Fractile
t_{11}	38	56	75	210
t_{12}	41	60	83	225
t_{13}	45	64	90	240
$'_{21}$	60	86	116	308
t_{22}	65	94	124	330
$'_{23}$	71	101	131	353
t_{31}	83	113	135	360
$'_{32}$	90	120	150	375
t_{33}	98	128	165	390

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only)

```
                    SEMI-MARKOV MODEL OF EARTHQUAKE RECURRENCE

RUN DESCRIPTION - NOAA SEISMIC EXPOSURE MAP 1

INFORMATION WHICH APPLIES TO ALL ZONES
---------------------------------------

NUMBER OF ZONES.......................................      7
NUMBER OF YEARS IN A UNIT TIME PERIOD.................   5.00
PERIOD OF INTEREST  - YEARS...........................  40.00
                    - TIME PERIODS....................      8
MAXIMUM NUMBER OF EARTHQUAKES ALLOWED.................      8
MAGNITUDE INCREMENT...................................    .50


RUN DESCRIPTION - NOAA SEISMIC EXPOSURE MAP 1

ZONE  1  - SHUMAGIN SEG

INFORMATION WHICH APPLIES TO THIS ZONE
--------------------------------------

NUMBER OF STATES......................................      3
MAGNITUDE OF THE LAST LARGE EARTHQUAKE................   8.00
                MAGNITUDE RANGE INDEX.................      1
TIME ELAPSED SINCE LAST LARGE EARTHQUAKE - YEARS...... 106.00
                                  - TIME PERIODS           21
ELAPSED TIME + PERIOD OF INTEREST - YEARS............. 146.00
                                  - TIME PERIODS......     29
NUMBER OF PARAMETERS IN THE SEMI-MARKOV MODEL.........     12
NUMBER OF SEGMENTS....................................      1

EARTHQUAKE MAGNITUDES

  STATE INDEX    DISCRETE MAGNITUDE    MAGNITUDE RANGE
  -----------    ------------------    ---------------
       1               8.050           7.800 - 8.300
       2               8.550           8.300 - 8.800
       3               9.050           8.800 - 9.300
```

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

BAYESIAN ESTIMATION OF MODEL PARAMETERS

PARAMETER 1 - M1

NUMBER OF DATA POINTS = 6
DATA VALUES -
7.800 7.900 6.200 7.800 9.200 8.100

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
8.300	8.500	8.700	9.300

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	6.0	5.0	-2.216	4.130		4.130
PRIOR 041A	5.0	4.0	-.452	.298	.592	.124
POSTERIOR	11.0	10.0	-1.414	4.041		2.963

PARAMETER 2 - M2

NUMBER OF DATA POINTS = 4
DATA VALUES -
8.400 8.300 9.100 8.400

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
8.300	8.500	8.700	9.300

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	4.0	3.0	-.313	.181		.181
PRIOR DATA	5.0	4.0	-.452	.298	.592	.124
POSTERIOR	9.0	8.0	-.413	.196		.132

PARAMETER 3 - M3

NUMBER OF DATA POINTS =
DATA VALUES -
8.200 8.700

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
8.300	8.500	8.700	9.300

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	2.0	1.0	-.511	.329		.329
PRIOR DATA	500	4.0	-.452	.298	.592	.124
POSTERIOR	7.0	6.0	-.469	.237		.138

PARAMETER 4 - 111

NUMBER OF DATA POINTS = 4
DATA VALUES -
2.000 3.000 1.000 1.000

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
50.000	75.000	10'.000	280.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	4.0	3.0	.448	.295		.295
PRIOR DATA	5.0	4.0	4.238	.512	1.464	.213
POSTERIOR	9.0	8.0	2.553	6.232		4.207

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

PARAMETER 5 - 112

NUMBER OF DATA POINTS = 1
DATA VALUES
31.000

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
55.000	80.000	11[.0[0	300.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. of FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	1.0	0	3.434	.000		.000
PRIOR DATA	5*0	4.0	4.353	.476	1.166	.198
POSTERIOR	6.0	5.0	4.134	.570		.293

PARAMETER 6 - T13

NUMBER OF DATA POINTS = 1
DATA VALUES -
6.000

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
60.000	85.000	12..000	320.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	1.0	.0	1.742	.000		.000
PRIOR DATA	5*C	4.0	.4-1	.446	.954	.186
POSTIR1OR	6.0	5.0	3.983	2.529		1.301

PARAMETER 7 1 2 1

NUMBER OF DATA POINTS = 2
DATA VALUES
1.000 1.000

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	2.75 FRACTILE	1.00 FRACTILE
80.000	115.000	155.000	41(,.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	2.0	1.0	.0.0	.000		.000
PRIOR DATA	5.0	4.0	4.694	.441	10C16	.184
POSTERIOR	7.0	6.:	3*353	9.204		5.369

PARAMETER 8 - T22

NUMBER OF DATA POINTS = 1
DATA VALUES -
1.000

PRIOR FRACTILES ARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
87.000	125.900	165.000	440.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	1.0	.0	.0 n	.000		.000
PRIOR DATA	5.0	4.0	4.77[	.431	.992	18?
POSTERIOR	6.0	5.0	3.975	7.655		3.937

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

PARAMETER 9 - T 2 3

NUMBER OF DATAPOINTS =
DATA VALUES -
19.000

PRIOR FRACTILESARE-

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
94.000	135.000	175.000	470.000

RESULTS OF COMBINING DATA AND PRIORSARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	1.0	.0	2.944	.000		.000
PRIOR DATA	5.0	4.0	4.841	.423	.972	.176
POSTERIOR	6.0	5.0	4.525	1.440		.741

PARAMETER 10 - T31

NUMBER OF DATA POINTS =
DATA VALUES -
1.000 1.000

PRIOR FRACTILESARE -

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
110.000	150.000	18[illegible].000	480.000

RESULTS OF COMBININGDATAANDPRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	2.0	1.0	3.5	.000		.000
PRIOR DATA	5.0	4.0	4.953	.316	.54.2	.131
POSTERIOR	7.0	6.0	3.538	1[illegible].163		5.929

PARAMETER 11 - 1 3 2

NUMBER OF DATA POINTS =

PRIOR FRACTILESARE-

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
120.000	160.000	20[illegible].000	500.000

RESULTS OF COMBINING DATA AND PRIORSARE AS FOLLOWS

	SAMPLE SIZE N	DEG. OF FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	.0	.0	[illegible]	sot		.000
PRIOR DATA	5.0	4.0	5.044	.296	.438	.123
POSTERIOR	5.0	4.0	5.044	.296		.123

PARAMETER 12 - 133

NUMBER OF DATA POINTS = 0

PRIOR FRACTILESARE-

0.25 FRACTILE	0.50 FRACTILE	0.75 FRACTILE	1.00 FRACTILE
130.000	170.000	22[illegible].000	520.000

RESULTS OF COMBINING DATA AND PRIORS ARE AS FOLLOWS

	SAMPLE SIZE N	DEG. of FREEDOM	MEAN (XBAR)	VARIANCE (SIGSQR)	FOURTH MOMENT	PARAMETER S SQUARE
OBJECTIVE DATA	.0	.0	[illegible]	.000		.000
PRIOR DATA	5.0	4.0	5.126	.278	.361	.116
POSTERIOR	5.0	4.0	5.126	.278		.116

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

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                    PROBABILISTIC CALCULATIONS IN THESEMI-MARKOVMODEL
                    -------- -------- -------- -------- -------- -------- ---

P(I,J)=PROBABILITY TH AT THE NEXTEARTHQUAKE AFTER
      ONE OF MAGNITUDE I WILLBEONE OF MAGNITUDE J

 P(1,1)= .7888886        P(1,2)= .1422288        P(1,3)= .0688827
 P(2,1)= .2866263        P(2,2)= .5676336        P(2,3)= .1457401
 P(3,1)= .3524834        P(3,2)= .5143812        P(3,3)= .1331354

H(I,J,M)=PROBABILIT V THAT THETIMEBETWEENEARTHQUAKES
         Magnitud es IAND J, RESPECTIVELY,WILLBEEQUAL T O    5.00 ● M(+ OR    2.50 YEARS)

 H(1,1,  1)= ● 4173135     H(1,2,1)= .0174705     H(1,3,  1)= .1354429
 H(1,1,  2)= .0784056      H(1,2,2)= .9223273     H(1,3,  2)= .0653548
 H(1,1,  3)= .0519821      H(1,2,  3)= .0305105   H(1,3,  3)= .0554509
 H(1,1,  4)= .0382544      H(1,2,4)= .037562S     H(1,3,  4)= .0478219
 H(1,1,  5)= .0298805      H(1,2,  5)= .0430134   H(1,3,  5)= .0417395
 H(1,1,  6)= .0242707      H(1,2,  6)= .0466775   H(1,3,  6)= .0367862
 H(1,1,  7)= .0202799      H(1,2,  7)= .0486100   H(1,3,  7)= .0326880
 H(1,1,  8)= .0172886      H(1,2, a )= .0490287   H(1,3,  8)= .0292523
 H(1,1,  9)= .0149884      H(1,2,  9)= .0462312   H(1,3,  9)= .0263431
 H(1,1, 10)= .0131665      H(1,2, 10)= .0465309   H(1,3, 10)= .0238538
 H(1,1, 11)= .0116922      H(1,2, 11)= .0442157   H(1,3, 11)= .0217068
 H(1,1, 12)= .0104786      H(1,2,12)= .0*15278    H(1,3, 12)= .0198412
 H(1,1, 13)= .0094629      H(1,2, 13)= .0386569   H(1,3, 13)= .0182093
 H(1,1, 14)= .0086034      H(1,2, 14)= .035744.   H(1,3, 14)= .0167733
 H(1,1, 15)= .0078678      H(1,2, 15)= .0328877   H(1,3, 15)= .0155026
 H(1,1, 16)= .0272321      H(102, 16)=.0301531    H(1,3, 16)= .0143727
 H(1,1, 17)= .0066781      H(1,2, 17)= .0275794   H(1,3, 17)= .0133632
 H(1,1, 18)= .0261916      H(1,2, 18)= .0251873   H(1,3, 18)= .0124576
 H(1,1, 19)= .0S57617      H(1,2,19)= .02.29843   H(1,3, 19)= .0116419
 H(1,1, 20)= .0053794      H(1,2,20)= .320969:    H(1,3, 20)= .0109045
 H(1,1, 21)= .0050376      H(1,2,21)= .9191343    H(1,3, 21)= .0102357
 H(1,1, 22)= .0047305      H(1,2,22)= .0174697    H(1,3, 22)= .0096271
 H(1,1, 23)= .0044533      H(102, 23)= .0159629   H(1,3, 23)= .0090718
 H(1,1, 24)= .0042022      H(1,2, 24)= .0146011   H(1,3, 24)= .0085635
 H(1,1, 25)= .0039736      H(1,2,25)= .0133712    H(1,3, 25)= ● 008C972
 H(1,1, 26)= .0037650      H(1,2,26)= .5122695    H(1,3, 26)= .3076683
 H(1,1, 27)= .0035740      H(1,2, 27)= .0112583   H(1,3, 27)= .0072728
 H(1,1, 28)= .0333974      H(1,2, 28)= .0103527   H(1,3, 28)= .0069074
 H(1,1, 29)= .0032367      H(1,2, 29)= .009534    H(1,3, 29)= ● C06E69:
 H(2,1,  1)= .3373111      H(2,2,  1)= .2551141   H(2,3,  1)= .0453456
 H(2,1,  2)= .0599112      H(2,2,  2)= .0562284   H(2,3,  2)= .0329355
 H(2,1,  3)= .0412776      H(2,2,  3)= .0466800   H(2,3,  3)= .0339402
 H(2,1,  4)= .0314285      H(2,2,  4)= .0319646   H(2,3,  4)= .0339600
 H(2,1,  5)= .0232796      H(2,2,  5)= .0263126   H(2,3,  5)= .0334077
 H(2,1,  6)= .021' 6S3     H(2,2,  6)= .0223279   H(2,3,  6)= .0324507
 H(2,1,  7)= .0194056      H(2,2,  7)= .0193595   H(2,3,  7)= .0312598
 H(2,1,  8)= .0156776      H(2,2,  8)= ● 0172597  H(2,3,  8)= .0299273
 H(2,1,  9)= .0135507      H(2,2,  9)= .015225    H(2,3,  9)= .0285526
 H(2,1, 10)= .0123759      H(2,2, 10)= .0137267   H(2,3, 10)= .0271529
```

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

```
H(2,1, 11)= .0111711      H( 2,2, 11)=.0124803      H(2,3, 11)= .525769?
H(2,1, 12)= .0101613      H( 2,2, 12)=.0114275      H(2,3, 12)= .0244238
H(2,1, 13)= ● 0093056     H(2,2,13)= .0105267       H(2,3, 13)= .0231282
H(2,1, 14)= .0 085718     H(2,2,14)= .009747>       H(2,3, 14)= .0218909
H( 2*1* 15)= .3 079361    H(2,2, 15)= .0 093671     H(2,3, 15)= .0207159
H(2,1, 16)= .0073804      H(2,2, 16)= .008468       H(2,3, 16)= .0196046
H(2,1, 17)= .0068908      H(2,2, 17)= .007936c      H(2,3, 17)= .0185568
H(2,1o 18)= .00 64564     H(2,2, 18)= .007462b      H(2,3, 18)= ● @17571r
H(2,1, 19)= .0060686      H(2,2, 19)= .007037'      H(2,3, 19)= .0166450
H( 2,1, 20)= .0057204     H(2,2, 20)= .0066529      H(2,3, 20)= .0157761
H(2,1, 21)= .0054063      H(2,2, 21)= .0063047      H(2,3, 21)= .0149614
H(2,1, 22)= .0051216      H(2,2,22)= .0'259877      H(2,3, 22)= .0141977
H(2,1, 23)= .0048624      H(2,2, 23)= .0056979      H(2,3, 23)= ● 013482C
H(2,1, 24)= .0046256      H(2,2,24)= .0954322       H(2,3, 24)= .0126111
H( 2,1* 25)= ● t' @**084  H(2,2, 25)= .0051876      H(2,3, 25)= .0121823
H(2,1, 26)= .0042086      H(2,2, 26)= .0049619      H(2,3, 26)= .3115926
H(2,1, 27)= .0040243      H(2,2, 27)= .0047529      H(2,3, 27)= .0110393
14(2*1* 28): .0038537     H(2,2, 28)= .004559'      H(2,3, 28)= .0105201
H(2,1, 29)= .0036955      H(2,2, 29)= .0043786      H(2,3, 29)= .0100325
H(3,1, 1)= .3246793       H(3,2, 1)= .0025443       H(3,3, 1)= .0020689
H(3,1, 2)= .0559384       H(3,2, 2)= .0023559       H(3,3, 2)= .0018723
H(3,1, 3)= .0387673       H(3,2, 3)= .00: 844       H(3,3, 3)= .0024291
H(3,1, 4)= .9296446       H(3,2, 4)= .0039165       H(3,3, 4)= .0030656
H(3,1, 5)= .0239420       H(3,2, 5)= .0048549       H(3,3, 5)= .0037850
H(3,1, 6)= .0200301       H(3,2, 6)= .005898*       H(3,3, 6)= .3045899
H(3,1, 7)= .0171778       H(3,2, 7)= .0070463       H(3,3, 7)= .0054809
H(3,1, 8)= .0150060       H(3,2,8)= ,?08290?        H(3,3, 8)= .0064565
H(3,1, 9)= .0132976       H(3,2,9)= .0096193        H(3,3, 9)= .0075122
H(3,1, 10)= .0119194      H(3,2, 10)= .0110185      H(3,3, 10)= .0086412
H(3,1, 11)= .0107846      H(3,2, 11)= .0124687      H(3,3, 11)= .0098332
H(3,1, 12)= .0098396      H(3,2, 12)= .0139471      H(3,3, 12)= .0110754
H(3,1, 13)= .0090280      H(3,2,13)= .0154283       H(3,3, 13)= .0 123521
H(3,1, 14)= .0083350      H(3,2, 14)= .0168851      H(3,3, 14)= .[136453
H(3,1, 15)= .0077336      H(3,2, 15)= .0182894      H(3,3, 15)= .0149351
H( 3*1* 16)= ● OC 72069   H(3,2,16)= .019614?       H(3,3, 16)= .0162005
H(3,1, 17)= .0067421      H(3,2,17)= .0208337       H(3,3, 17)= .0174203
H(3,1, 18)= .0063290      H(3,2,18)= .021926<       H(3,3, 18)= .0185735
H(3,1, 19)= .0059596      H(3,2, 19)= .0228726      H(3,3, 19)= .0196406
H(3,1, 20)= .0056275      H(3,2,20)= .023659}       H(3,3, 20)= .0206042
H(3,1, 21)= ● tC 53274    H(3,2, 21)= .0242771      H(3,3, 21)= .0214496
H(3,1, 22)= .0050549      H(3,2,22)= .0247225       14(3,3, 22)= .0221653
H( 3*1* 23)= .0048066     H(3,2,23)= .0249965       H(3,3, 23)= .0227436
H(3,1, 24)= .0045793      H(3,2, 24)= .0251044      H(3,3, 24)= .0231801
H(3,1, 25)= ● OG43737     H(3,2, 25)= .0250552      H(3,3, 25)= .0234742
H(3,1, 26)= .004 1785     H(3,2,26)= .024861"       H(3,3, 26)= .?236287
H(3,1, 27)= .0 40009      H(3,2, 27)= .024536       H(3,3, 27)= .0236490
H(3,1, 28)= .0038364      H(3,2,28)= .024,959       H(3,3, 28)= .3235435
H(3,1, 29)= .0036837      H(3,2, 29)= .0235569      H(3,3, 29)= .0233220

EARTHQUAKE PROBABILITIES FOR THE NEXT      5.'' YEARS

PROBABILITY    NO. OF EARTHQUAKES OF EACH MAGNITUDE
                 7.9-0.? 8.3-8.48.8-9.3
  .96975772        3        0
  .0164047?        1        0
```

Fig, B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.01092240	c	1	0
.00291510	o	0	1

EARTHQUAKE PROBABILITIES FOR THE NEXT 10.0 YEARS

PROBABILITY	No. OF EARTHQUAKES of EACH MAGNITUDE 7.8-8.3	8.3-8.8	8.8-9.3
.94158697	o	0	0
.02625387	1	o	0
.01819287	0	1	0
.00540068	2	o	0
.03332359	0	0	1
.09156169	c	2	0
.02109676	1	1	0
.00048687	1	0	1
.00007600	0	1	1
.00000080	0	0	2

EARTHQUAKE PROBABILITIES FOR THE NEXT 15.0 YEARS

PROBABILITY	NO. OF EARTHQUAKES OF EACH MAGNITUDE 7.8-8.3	8.3-8.8	8.6-9.3
.91529242	0	0	0
.03441904	1	0	0
.02425734	0	1	[illegible]
.0965783	2	0	0
.00153597	0	c	1
.00298314	0	2	c
.00196917	1	1	0
.03177790	3	0	c
.00094524	1	0	1
.00036501	2	1	0
.03022905	0	3	0
.00019218	o	1	1
.00017781	2	0	1
.00016145	1	2	0
.00001979	1	1	1
.00001110	0	2	1
.00000325	1	0	2
.09532219	0	0	2
.00000005	o	1	2

EARTHQUAKE PROBABILITIES FOR THE NEXT 20.0 YEARS

PROBABILITY	NO. Of EARTHQUAKES OF EACH MAGNITUDE 7.8-0.3	8.3-8.8	8.8-9.3
.89070056	o	0	0
.04134509	1	c	0
.02'43794:	c	1	0
.01362784	2	0	0
.00958317	0	0	1

Fig, B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00434562	c	2	0
.00351354	3	0	0
.00281754	1	1	0
.00142568	1	0	1
.00072816	2	1	0
.00058534	4	0	
.00048248	0	3	
.00038082	2	0	1
.05?34?55	0	1	1
.00032835	1	2	0
.00012146	3	1	:
.00006431	3	0	1
.00005399	2	2	0
.00004990	1	1	1
● OG9C3317	0	4	0
● oGrc3c57	0	2	1
.00002376	1	3	0
.00000811	1	0	2
.00000785	2	1	1
.00000435	0	0	2
.00000293	1	2	1
.00000162	0	3	1
.00000159	2	0	2
.00000016	0	1	2
.00000010	1	1	2

EARTHQUAKE PROBABILITIES FOR THE NEXT 25.00 YEARS

PROBABILITY	No. OF EARTHQUAKES OF EACH MAGNITUDE 7.8-0.3	8.3-8.8	8.8-9.3
.86765619	o	0	0
.04729732	1	c	0
.03373078	0	1	0
.01731331	2	o	0
.01148524	o	0	1
.00564697	0	2	n
.00530531	3	0	0
.00365320	1	1	0
.00191974	1	0	1
.02126568	4	c	0
.00112006	2	1	·
.00076103	0	3	J
.00226136>	2	0	1
.00054183	0	1	1
.00051387	1	2	(
.00026651	3	1	r
.[31927:	5	0	
.00015047	3	2	1
.00012081	2	2	.
.00009071	1	1	1
.00007718	n	4	
.00005998	0	2	1
.00005397	1	3	
.00004041	4	1	
.00002307	4	0	i

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00002110	2	1	1
.00001805	3	2	0
.00001447	1	c	2
.00000808	1	2	1
.00000788	2	3	0
.00000743	0	0	2
.00000483	0	3	1
.00000480	0	5	0
.00000424	2	0	2
.00000350	1	4	0
.00000303	3	1	1
.00000117	2	2	1
.00000072	3	0	2
.00000043	1	3	1
.00000038	0	1	2
.00000033	1	1	2
.00000024	0	4	1
.00000006	2	1	2
.00000003	0	2	2
.00000001	1	2	2

EARTHQUAKE PROBABILITIES FOR THE NEXT 30.00 YEARS

PROBABILITY	NO. OF EARTHQUAKES OF EACH MAGNITUDE 7.8-8.3	8.3-8.8	8.9-9.5
.84602108	0	c	[illegible]
.05243002	1	0	[illegible]
.03743771	0	1	0
.02371887	2	0	0
.01225686	0	0	1
.00710174	3	0	0
.00487567	0	2	0
.00448261	1	1	
.00241805	1	0	i
.00203682	4	0	c
.03153667	2	1	0
.02105403	0	3	c
.03286886	2	0	1
.00076846	0	1	1
● 02271613	1	2	0
.02545321	5	o	c
.02743811	3	1	c
.00025771	3	0	1
.00020222	2	2	0
.00014184	1	1	1
.00013089	0	•	r
.00009679	o	2	1
.00009672	4	1	0
.00009151	1	3	0
● ofl'053b4	6	r	0
.00005851	4	o	1
.00004407	3	2	c
.00004021	2	1	1
.00002216	1	c	2
.00001979	2	3	n

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00001575	1	2	1
.00001345	5	1	0
.00001223	0	5	
.00001163	0	0	2
.00000990	0	3	1
.00000877	1	4	0
.00000869	3	1	1
.00000822	5	2	1
.00000793	2	0	2
.00000603	4	2	
.00000343	2	2	1
.00000266	3	3	0
.00000203	3	0	2
.00000130	1	3	1
.00000116	2	4	0
.00000115	4	1	1
.00000076	r	4	1
.00000074	o	1	2
.00000072	1	1	2
.00000070	0	6	
.00000051	1	5	c
.00000045	3	2	1
.00000031	4	0	2
.00000019	2	1	2
.00000017	2	3	1
.00000007	0	2	2
.00000006	1	4	1
.00000005	1	2	2
.00000003	0	5	1
.00000003	3	1	2
.00000001	1	0	3
.00000001	2	0	3

EARTHQUAKE PROBABILITIES FOR THE NEXT 35.0 YEARS

PROBABILITY	NO. OF EARTHQUAKES OF EACH MAGNITUDE ?.?-8.3	8.3-8.9	6.8-9.3
.62567155	0	0	0
.05687027	1	0	0
.04359875	o	1	0
.0238534'?	2	0	3
.01490939	0	0	1
.03686944	3	3	0
.00802669	c	2	
.00530891	1	1	0
.00291721	1	0	1
.00286388	4	0	0
.0'3197557	2	1	0
.00135401	0	3	0
.00114362	2	0	1
.00102487	0	1	1
.00093386	1	2	0
.00077292	5	0	0
.00063335	3	1	0
.00038262	3	0	1

Fig. B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00029726	2	2	0
.00020288	1	1	1
.00019222	0	4	0
.00016917	4	1	[illegible]
.00016112	6		0
.00014363	[illegible]	2	1
.00013602	1	3	0
.00010607	4	0	1
.00007849	3	2	0
.00006539	2	1	1
.00003575	2	3	0
.00003485	5	1	0
.00003106	1	0	2
.00002609	1	2	1
.00002245	5	0	1
.00002218	0	5	0
.00002089	7	[illegible]	0
.00001733	3	1	1
.00001715	0	0	2
.00001704	[illegible]	3	1
.00001599	1	4	0
.00001596	4	2	
.00001265	2	0	2
.00000721	3	3	0
.00000699	2	2	1
.00000447	6	1	0
.00000399	3	0	2
.00000349	4	1	1
.00000321	2	4	7
.00000291	6	0	1
.00000270	1	3	1
.00000202	5	2	
.00000193	0	6	
.00000164	0	4	1
.00000141	3	2	1
.00000141	1	5	0
.00000133	1	1	2
.00000130	0	1	2
.00000092	4	0	2
.00000090	4	3	0
.00000055	2	3	1
.00000043	2	1	2
.00000043	5	1	1
.00000040	3	4	[illegible]
.00000021	1	[illegible]	1
.00000017	2	5	0
.00000017	4	2	1
.00000014	0	2	2
.00000013	5	0	2
.00000012	1	2	2
.00000012	0	[illegible]	1
.00000011	0	7	
.00000010	3	1	0
.00000008	1	6	
.00000007	3	3	1
.00000003	2	2	2
.00000003	2	[illegible]	[illegible]

Fig, B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00000003	1	0	3
.00000003	2	4	1
.00000001	4	1	2
.00000001	0	3	2
.00000001	3	0	3

EARTHQUAKE PROBABILITIES FOR THE NEXT 40.00 YEARS

PROBABILITY	NO. OF EARTHQUAKES OF EACH MAGNITUDE 7.8-8.?	8.3-8.8	8.8-9.3
.80649714	0	0	0
.06071218	1	0	0
.04329350	0	1	0
.02672915	2	0	0
.01665192	0	0	1
.01058675	3	0	0
.00909893	0	2	0
.00613246	1	1	0
.03372472	4	0	0
.00301234	1	0	1
.00243469	2	1	0
.05165565	0	3	0
.00142426	2	0	1
.00130767	0	1	1
.00116591	1	2	0
.00113842	5	0	0
.00085034	5	1	0
.03352225	3	0	1
.00024535	2	2	0
.00029038	6	0	0
.00027346	1	1	1
.9.7.25967	0	4	0
.00025669	4	1	0
● 0)"1954?	0	2	1
.00018732	1	3	0
.00016472	4	0	1
.00012124	3	2	0
.00009675	2	1	1
.00006454	5	1	0
.00005697	7	0	0
.00005591	2	3	0
.00004293	5	0	1
.00004106	1	0	2
.09293925	1	2	1
.00003440	0	5	0
.00003011	4	2	0
.00002929	3	1	1
.00002638	0	3	1
.00002521	1	4	0
.00002421	0	0	2
.00001833	2	0	2
.00001380	3	3	0
.0'3"91248	6	1	0
.00001203	2	2	1
.00000852	6	0	1

Fig B-1 - Partial MARKOV Printed Output (for the Shumagin Gap source only) (continued)

.00000730	4	1	1
.00000688	8	0	0
.00000661	3	0	2
.00000621	2	4	0
.00000574	5	2	0
.00000471	1	3	1
.00000371	0	6	0
.00000301	3	2	1
.00000296	0	4	1
.00000275	1	5	0
.00000261	4	3	0
.00000219	1	1	2
.00000211	0	1	2
.00000190	4	0	2
.00000149	7	1	0
.00000138	5	1	1
.00000120	2	3	1
.00000117	3	4	0
.00000103	7	0	1
.00000081	2	1	2
.00000067	6	2	0
.00000057	4	2	1
.00000052	2	5	0
.00000046	1	4	1
.00000040	5	0	2
.00000030	5	3	0
.00000030	0	7	0
.00000027	0	5	1
.00000026	0	2	2
.00000024	1	2	2
.00000023	3	1	2
.00000023	3	3	1
.00000023	1	6	-
.00000016	6	1	1
.00000013	4	4	0
.00000009	2	4	1
.00000007	2	2	2
.00000006	5	2	1
.00000006	3	5	0
.00000005	2	0	3
.00000005	6	0	2
.00000005	4	1	2
.00000005	1	0	3
.00000003	1	5	1
.00000003	0	3	2
.00000003	4	3	1
.00000003	2	6	0
.00000002	3	0	3
.00000002	1	3	2
.00000002	0	6	1
.00000002	3	2	2
.00000001	0	8	-
.00000001	0	0	3
.00000001	1	7	
.00000001	3	4	1

MARGINAL PROBABILITIES

SEGMENT 1
PROPORTION =1.0000
OUTPUT UNIT 17

DISCRETE MAGNITUDE	NUMBER OF EARTHQUAKES 0	1	2	3	4	5	6	7	8
8.050	.8788585	.0719999	.0311855	.0121350	.0041888	.0012538	.0003123	.0000595	.0000067
8.550	.9318633	.0547676	.0110829	.0019482	.0002957	.0000380	.0000040	.0000003	
9.050	.9758666	.0240347	.0000986	.0000002					

Fig. B-2 - Disk Output from MARKOV

```
 1.      SHRMAOIN SEG                                                                                  SEGMENT  1
 2.      3     8.0500       .5000       40.001.00000000
 3.                8          7           3
 4.        .8788585   .0719999   .0311855   .0121350   .0041888   .0012538   .(?)W,.41 23.0000395
 5.        .0000069
 6.        .9318633   .0547676   .0110029   .0019482   .0002557   .0000490   .0000040   .0000003
 7.        .9758666   .0240347   .0009986   .0000002
 8.      SEM101                                                                                        SEGMENT  1
 9.      3     8.0500       .5000       40.0010000.00000
10.                8          7           3
11.        .8228836   .1051228   .0456769   .0177876.0061 .375   .0018562   .0004577   .0000875
12.        .0000102
13.        .8966504   .0840819   .0161981   .0026262   .0003903   .0000480   .0000048   .0000004
14.        .9679829   .0318976   .0001194   .0000002
15.      PICK SEG 1                                                                                    SEGMENT  1
16.      3     8.0500       .5000       40.001.00000000
17.                8          6           2
18.        .9390254   .0356775   .0158150   .0064059   .0022342   .0006872   .0001766   .0000330
19.        .0000043
20.        .9705281   .0248979   .0055337   .0006607   .0000710   .0000078   .0000007
21.        .9922402   .0077404   .0000194
22.      PICK SEG 2                                                                                    SEGMENT  1
23.      3     8.0500       .5000       40.001.00000000
24.                8          6           2
25.        .9434148   .0338440   .0148021   .0058861   .0019120   .0005694   .0001420   .0000274
26.        .0000033
27.        .9814665   .0157449   .0024095   .0002432   .0000410   .(>{60,:,[,44   .0000064
28.        .9947117   .0052767   .0000116
29.      PICK SEGMENT 3                                                                                SEGMENT  1
30.      3     8.0500       .5000       40.001.00000000
31.                8          6           2
32.        .9467484   .0329614   .0134699   .0050268   .0016688   .0004829   .0001173   .0000221
33.        .0000026
34.        .9873218   .0102219   .0016107   .0000167   .0000260   .0000027   .0000002
35.        .9961791   .0038134   .0000075
36.      YAKATOM GAP                                                                                   SEGMENT  1
37.      3     8.0500       .5000       40.001.00000000
38.                8          8           3
39.        .9224209   .0402279   .0211992   .0099761   .0041319   .0014665   .0004252   .0000913
40.        .0000111
41.        .8890026   .0892289   .0265190   .0052644   .0010028   .0001598   .0000205   .0000019
42.        .0000001
43.        .9417091   .0572416   .0010447   .0000046
44.      YORUTAI GAP                                                                                   SEGMENT  1
45.      3     8.0500       .5000       40.001.00000000
46.                8          6           2
47.        .9914666   .0050913   .0021871   .0008486   .0002927   .0000875   .0000217   .0000041
48.        .0000004
49.        .9872123   .0118337   .0024369   .0004471   .0000680   .0000090   .0000010
50.        .9973885   .0025985   .0000129
```

APPENDIX C

ASSESSMENT OF INPUTS FOR THE SEMI-MARKOV MODEL

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APPENDIX C

ASSESSMENT OF INPUTS FOR THE SEMI-MARKOV MODEL

The inputs necessary for using a semi-Markov model can be obtained in the following steps:

1. Select the zone for applying the semi-Markov model.
2. Define states and unit time.
3. Assess transition probabilities.
4. Assess probability distributions of holding times.
5. Compile available historical seismicity data.
6. Define initial seismicity conditions for the zone.

These steps were followed by the SRU participants in their development of the seismicity and geology inputs to the initial application of the SEISMIC.EXPOSURE software package to the Gulf of Alaska study region. A brief description of each step follows. Volume II of the project documentation discusses in detail the process of implementation of the software.

C.1.0 SELECT ZONES FOR APPLYING THE SEMI-MARKOV MODEL

Zones are selected primarily on the basis of spatial patterns identified through historical seismicity of the study area. For example, seismic gaps recognized in the literature may be the zones of interest selected for the study. Each zone should be capable of generating large earthquakes as defined by the user.

C.2.0 DEFINE STATES AND UNIT TIME

Intervals of earthquake magnitude are used to define discrete states of a semi-Markov process. The width of each interval

should be constant. The width should be selected such that no more than four states are defined in the magnitude range of interest. Values in the range of 0.2 to 0.5 may be reasonable for a given interval width.

A unit time selected for the model should be small enough so that the probability of two or more transitions (occurrences) of large earthquakes in unit time is negligible and large enough so that only a limited number of transitions need to be analyzed during a selected period of interest. Typical choices of unit time are 2 to 8 years.

Because the upper range of holding times between great earthquakes may be 200 years or more, historical seismicity data of about 80 to 100 years are generally inadequate to provide reasonable estimates of the parameters of a semi-Markov model. A Bayesian procedure, therefore, is utilized in the MARKOV program to combine historical seismicity data and expert judgments.

The mathematical theory for doing this is described by Patwardhan and others (1980). Steps 3 and 4 involve the assessment of expert judgments in the form of subjective probability distributions. Step 5 describes the analysis of historical seismicity data.

C.3.0 ASSESS TRANSITION PROBABILITIES

A transition probability, p_{ij}, is the likelihood that the magnitude of the next large earthquake will be M_j 9iven an earthquake of magnitude M_i at the present time. To obtain p_{ij}, the continuous probability distribution of the magnitude of the earthquake following an earthquake of magnitude M_i is first assessed. This continuous distribution is then divided into discrete intervals defined by the states. The program

MARKOV requires four fractiles (0.25, 0.50, 0.75, and 1.0) of the earthquake magnitude following an earthquake of magnitude M_i for each i within each zone.

C.4.0 ASSESS PROBABILITY DISTRIBUTION OF HOLDING TIME

The probability distribution t_{ij} (m) specifies the probability that the holding time between two successive earthquakes of magnitude in state i (M_i) and state j(M_j), respectively, is m units of time. A continuous probability distribution of the holding time is assessed. Within the program, the continuous distribution is subdivided into discrete intervals at selected time increments to obtain t_{ij}(m). The program MARKOV requires the four fractiles (0.25, 0.5, 0.75, and 1.0) of the holding time between Mi and Mj for each i and j within each zone.

C.5.O COMPILE AVAILABLE HISTORICAL SEISMICITY DATA

The date and magnitude of large earthquakes that occurred in each of the zones are tabulated available records of historical seismicity. This information is then analyzed to obtain all the instances in which an earthquake of magnitude Mj followed an earthquake of magnitude Mi. The data are finally summarized in two tables: one showing the magnitudes of earthquakes that follow an earthquake of magnitude Mi for each i and the other showing the holding time in years between successive earthquakes of magnitude Mi and Mj.

C.6.0 DEFINE INITIAL SEISMICITY CONDITIONS OF EACH ZONE

The magnitude of the last large earthquake (M_o) in a Zone and the time elapsed since then (to) define the initial seismicity conditions of the zone. The historical seismicity data in Section 5.0 are used to estimate M_o and to.

C.7.0 DISCUSSION

The steps required to prepare input data for a semi-Markov characterization of large and great earthquakes have been outlined. The essence of the semi-Markov model as implemented in the MARKOV program is that it provides occurrence probabilities of various magnitude earthquakes that are based on an interplay between what has been seen historically to occur in a region, the perception by experts of that record, and how it might relate to projections of future seismicity. Hence, the development of the priors on the magnitude transitions and holding times requires consistent checking for internal consistency.

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