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SEISMIC HAZARD MAPPING FOR GUATEMALA

by

Anne S. Kiremidjian
Haresh C. Shah
Lester Lubetkin

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The John A. Blume Earthquake Engineering Center
Department of Civil Engineering
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16. Abstract (Limit: 200 words)

The seismic risk study for Guatemala includes the collection and description of geological and seismological environment and the use of that information in developing iso-acceleration maps of Guatemala. Results are given on future probable seismic hazard for Guatemala which can be utilized by engineers in formulating the seismic codes, by planners in future developments, and by the insurance companies in evaluating the seismic risks and rates. Various state-of-the-art models are used to develop this hazard information. Two types of models were used in developing the seismic hazard maps of the country. The first model was the Poisson occurrence model where the seismic recurrence for various sources was based on past earthquake data and on a hypothesized upper Richter magnitude. These maps are presented for four separate return periods. The Bayesian model, where subjective and objective information on the number of occurrences and the magnitude level is used, is presented. For this model, the attenuation relationship is assumed to be probabilistic with uniform distribution and the scatter of this distribution is represented by the coefficient of variation. Iso-acceleration and iso-duration maps developed using this Bayesian model are also given. Acceleration zone graphs can be used to evaluate the level of peak ground acceleration as a function of return period.

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PREFACE

This is the first report of the study on Seismic Risk for Guatemala. This phase of the study includes the collection and description of geological and seismological environment and the use of that information in developing iso-acceleration maps of Guatemala. This phase of the study gives results on future probable seismic hazard for Guatemala which can be utilized by engineers in formulating the seismic codes, by planners in future developments and by the insurance companies in evaluating the seismic risks and rates. Various state-of-the-art models are used to develop this hazard information.

Phase II of the project will involve the following topics.

- A thorough study of the 1973 UBC, the 1976 UBC and the ATC-3 work currently being completed. The above codes will be evaluated with the seismicity of Guatemala in mind. Such an evaluation will permit the engineers and planners in Guatemala to appreciate and understand the current code levels and their relationships with future seismic loading demands.
- A detailed discussion on the purpose and effects of earthquake codes will be presented. This will include the history of earthquake loading criteria, the relation of design loads and quality of structures, the objectives and qualities of workable seismic codes and the role of design detailing and design forces in providing a safe economic construction.

- Introduction to the Proposed Seismic Design Provisions. This will take into account the current codes, their advantages, their shortcomings and the available solutions to eliminate or reduce the shortcomings. This part of the study will explain in detail the concept of acceptable risk and the associated loading levels from the hazard maps of Guatemala. The study will also develop the shape and levels of various design spectra. These spectra will include the site characteristics information.
- A detailed description of the type of structural systems, their effects on the design level and a step-by-step design procedure will be developed.
- Based on the spectral approach of seismic design, a simplified equivalent static load method, similar to the 1976 UBC method of design, will be developed. It should be emphasized here that a workable code should have the following four ingredients.

  1) Simplicity.
  2) Rationality.
  3) Freedom to use responsible ingenuity for special structures.
  4) Reward and encouragement for using dynamic analysis when merited by the complexity of a given structure.

  In developing the methodology in part II of this study, the above four ingredients will be kept in mind.
- Finally, a detailed comparison with the proposed methodology and the 1976 UBC will be made. This will be done with the seismic environment of Guatemala in mind.

It is estimated at this time that the results of phase II study will be submitted before the end of September 1977.

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CHAPTER I

INTRODUCTION

Scope

In this chapter the general background under which this study was initiated is presented. The concepts of seismic hazard and risk are described. The main objectives of the current study are presented.

....

I-1 Introduction

On February 4, 1976 at 3:01 A.M. (local Guatemalan time), central Guatemala experienced a major earthquake. The surface-wave magnitude (M_s) of this earthquake was 7.5 and the body wave magnitude (M_b) was 5.8. The hypocentral location was 15.32°N latitude and 89.08°W longitude with a focal depth of about 5 kilometers. Various aftershocks followed the main event for days and weeks. It is estimated that millions of dollars of damage and thousands of lives were lost. The resulting economic hardships and the disruption in the way of life can not be fully estimated.

In the chaos of rescue, public care and debris removal which are the usual results of such earthquakes, it is very difficult for public officials and engineers to be concerned about why some buildings survive and others collapse. The building efforts which follow such events bring up many questions. Are existing design requirements adequate? What are the future seismic hazards? What should be the acceptable level of seismic risk? How should the information on future seismic hazards and acceptable risk be translated into a rational, simple and acceptable design methodology? Should similar land uses be permitted in the future for areas which suffered major damage? These and numerous other questions become especially relevant after a significant damaging event. The loss of life and damage brought about by the earthquake-induced landslides in Guatemala City demonstrated the need for proper land use planning.

The decision processes which lead to the answers for the numerous questions posed in the previous paragraph are a complex mixture of socio-economic constraints, political expediency and the general engineering knowhow. In times when no significant earthquake events have taken place, the decision making processes go on at a slow rate, while the decisions immediately after the damaging event are often based on expediency and, at times, on incomplete and irrational analysis. The attention is only focused on collapsed or heavily damaged structures and the reaction is that these failures should never be allowed to happen. The public, through their representative officials, demand doubling or tripling of the existing design levels -- with resulting higher costs and delayed construction.

Under this barrage of emergency actions, public pressure and all sorts of "consulting advice" from experts from all over the world, it is remarkable that the engineers, planners and decision makers in Guatemala decided to initiate a systematic study of seismic hazard and risk analysis with long range perspective. Such a study has two basic goals.

1) To develop a seismic hazard map for Guatemala, based on all the available seismological and geological information.
2) Based on the information of future seismic hazards in various parts of the country and based on the concept of acceptable level of risk, develop a rational and simple design methodology for lateral load resistance.

This report is the result of achieving the first goal mentioned above. The study was conducted at Stanford University and supported by the following organizations in Guatemala.

1. Cámara Guatemalteca de la Construcción
2. Universidad de San Carlos de Guatemala
3. Banco Nacional de la Vivienda
4. Instituto Nacional de Electrificación
5. Banco de Guatemala

In a second report (to be published in the future) the probabilistic hazard information will be used to develop a design methodology which if implemented could help in reducing the future seismic risk to an acceptable level. A detailed comparison between the suggested method and the current and proposed California codes will also be presented.

The results of seismic hazard evaluation presented in this report should be used as a base for planning and decision making in Guatemala. Such a study can also be utilized by land use planners, investors and insurance companies. In general, the results of this study (Phase I) can provide professionals in Guatemala with tools and procedures for risk analysis and planning.

I-2 Some Basic Concepts Concerning Hazard and Risk

In order to convey the importance of seismic hazard and risk analysis to the reader, some basic notions are presented in this section. In the earthquake engineering literature, there is in general, ambiguity regarding two words. They are: Hazard and Risk. Seismic hazard is regarded by many to be synonymous with seismic risk. Earthquake engineers and planners use these two words loosely and interchangeably in their work. There is some danger in this ambiguity since these two words within the context of earthquake engineering have different meanings.

Seismic hazard is defined as "expected occurrence of a future adverse seismic event".

Seismic risk is defined as "expected consequences of a future seismic event".

Consequences may be life loss, injury, economic loss, function loss and damage. Expected hazard and expected risk have an implication of future uncertainty. Hence, it is not surprising that principles of probabilistic forecasting and decision making are essential in any seismic hazard or seismic risk analysis.

In a recent report to the United States Congress (1972) by the U.S. Executive Office of the President, Office of Emergency Preparedness, the following two recommendations were made.

1) The development of seismic hazard maps is an essential first step in hazard reduction and preparedness planning.
2) The greatest potential for reducing the loss of life and property from earthquakes lies in restructuring the use of land in high risk areas and in imposing appropriate structural engineering and materials standards both upon new and existing buildings.

As can be seen from above, it is essential that a seismic hazard map be prepared for Guatemala as a first step.

Finally, it should be kept in mind that the work and results presented here depend on the available data base and information. The reliability of results are at best as good as the reliability of the data on which the results are based. It is very easy to attack and criticize any work from the point of view of data reliability. However, it is very difficult to obtain long-range reliable data. The best available information through various organizations and researchers have been used in this study. The forecasts and predictions are based on those data. However, if in the future more reliable data are available, the model can easily accommodate the inclusion of new information and update the results. At this time, the authors of this report feel that the results presented here represent the "best available" estimates of the future forecasts.

CHAPTER II

GEOLOGIC SETTING OF GUATEMALA

Scope

In this chapter the general geologic and seismologic setting of Guatemala and surrounding regions is presented. A description of the major plates and plate boundaries is given along with their relationship to seismically active zones. Guatemala has been divided into five geologic and structural regions which are individually discussed. The volcanic activity is described as are major faults and structural trends. This chapter concludes with some suggestions relating to seismic zoning.

II-1 Introduction

Guatemala is located within the circumpacific "Ring of Fire", a zone of intense seismic and volcanic activity. The modern plate tectonics model explains this high level of activity as being associated with the motions of crustal plates and the interactions at their boundaries. Most of Central America lies on the western portion of the Caribbean Plate. However, Guatemala is situated athwart the boundary between the Caribbean Plate to the south and the North American Plate to the north (see Figure 2-1). This boundary is marked by the generally east-west trending Cayman (or Bartlett) trough, a deep submarine fault valley over 4 km. deep. To the west, the landward extension of this trough coincides with the Motagua and Polochic fault zones. The motion along this boundary is predominantly left lateral (opposite side moving to the left) movement (Molnar and Sykes, 1969).

West of the Caribbean Plate lies the Cocos Plate, the boundary between the two being the Middle America Trench. The Cocos Plate is moving generally northeast and being thrust under the Caribbean Plate (Molnar and Sykes, 1969; Jordan, 1975). The Middle America Trench is due to this underthrusting, or subduction, of the Cocos Plate beneath the Caribbean Plate. Other

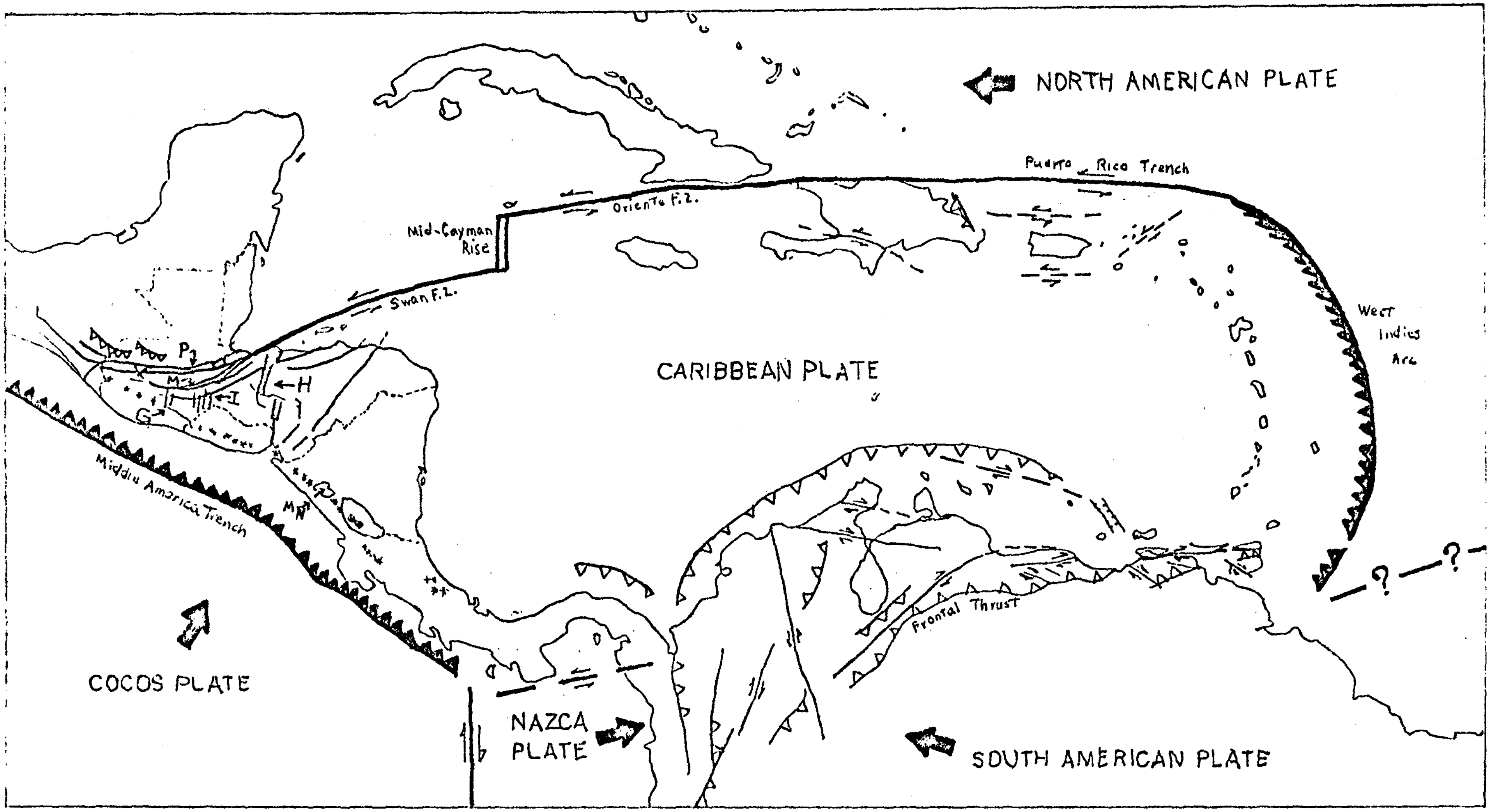


Figure 2-1. Structure and boundaries of the Caribbean Plate. P--Polochic fault zone, M--Motagua fault zone, G--Guatemala City graben, I--Ipala graben, H--Honduras depression, MN--Managua, Nicaragua (From Bilideau, 1976, modified from Jordan, 1975)

features normally associated with a "subducting" plate boundary are also observed along the western and central portions of Central America, including a northwesterly, arcuate trending chain of andesitic stratovolcanoes, a band of shallow to intermediate depth earthquake foci, and an oceanic trench as previously mentioned.

The Middle America Trench is a four to five kilometer deep depression located approximately 100 kilometers west of Central America, extending from southern Mexico southward to Costa Rica. Along the landward margin of the trench is a band of intense shallow seismic activity, with earthquake foci increasing in depth to the northeast, defining a northeast dipping slab-like zone. This zone of friction is commonly known as the Benioff Zone.

A chain of Quaternary and active volcanoes parallels the trench and is located about 100 to 200 kilometers northeast of the trench and directly above the earthquakes with focal depths of about 100 to 200 kilometers (intermediate depth foci).

Guatemala is located due east of the junction of the Cocos, Caribbean and North American Plates. This feature is known as a triple junction. The tectonics associated with triple junctions is often quite complex and confusing.

II-2 Nuclear Central America:

Schuchert (1935) names "the ancient folded and faulted mountain land of Central America" Nuclear Central America. This portion of Northern Central America includes Chiapas of Mexico, Guatemala, Belice, Honduras, El Salvador and much of northern Nicaragua. Guatemala itself can be further subdivided into five "morphotectonic" units, as described by Dengo and Bohnenberger (1969). These morphotectonic units were "established on the basis of their internal constitution and external relief" (Guzman and DeCserna, 1961), and are a combination of the physiographic and tectonic features of the various subdivisions. The five subdivisions are the Pacific Coastal Plain, the Pacific Volcanic Chain, the Volcanic Ranges and Plateaus, the Sierras of Northern Central America and the Yucatan Platform (see Figure 2-2). Other investigators, such as Bonis (1967), Schuchert (1935), and Brineman and Vinson (1961), have used various different divisions and classification systems. However, the classification system used herein was selected because it appeared to be the most complete and comprehensive.

Pacific Coastal Plain:

The Pacific Coastal Plain is a narrow coastal plain about 50 kilometers wide, located along the Pacific side of Northern Central America, extending from El Salvador northward into southern Mexico. This coastal plain is composed of a thick accumulation of sands, gravels, pumice and bouldary laharic deposits (mudflows of volcaniclastic materials), most of which were derived from the adjacent volcanic chain and highlands. The boundary between this unit and the Pacific Volcanic Chain is thought to be a series of major faults which have been buried under alluvial deposits (Agos, 1958), based on the interpretation of airborne magnetometer data.

Pacific Volcanic Chain:

A chain of active and Quaternary andesitic volcanic cones extends from southernmost Mexico, across Guatemala into El Salvador, paralleling the Pacific Coast with a generally northwest trend.

This precipitous volcanic chain stretches longitudinally across much of Central America, and can be divided into several short segments (see Figure 2-3) based on prominant volcanic lineaments, seismicity and quaternary structures (including faulting) (Carr, 1976; Carr, Stoiber and Drake, 1974). The boundaries separating these different segments are often zones of transcurrent faulting, and commonly appear to be tectonically very active.

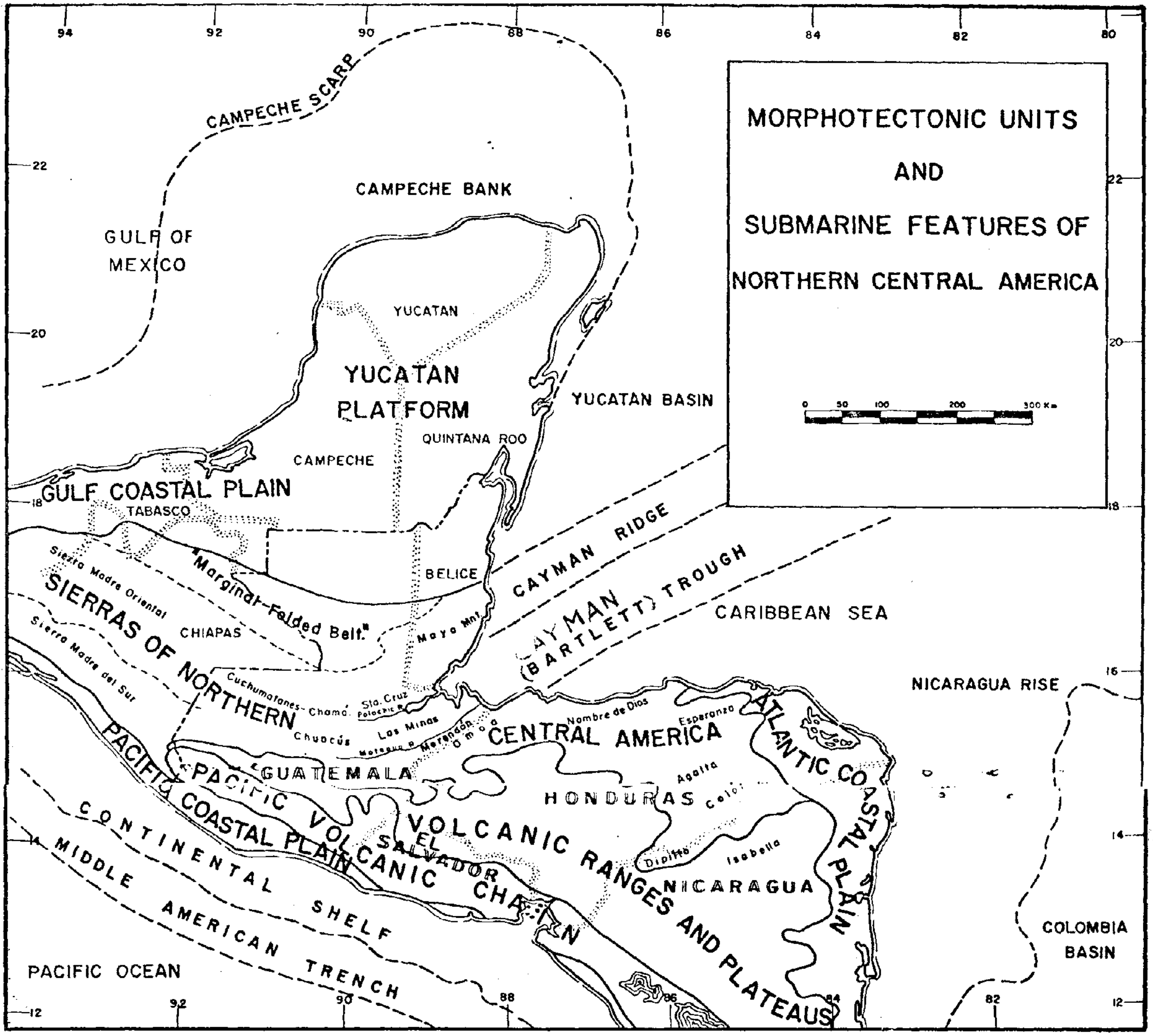
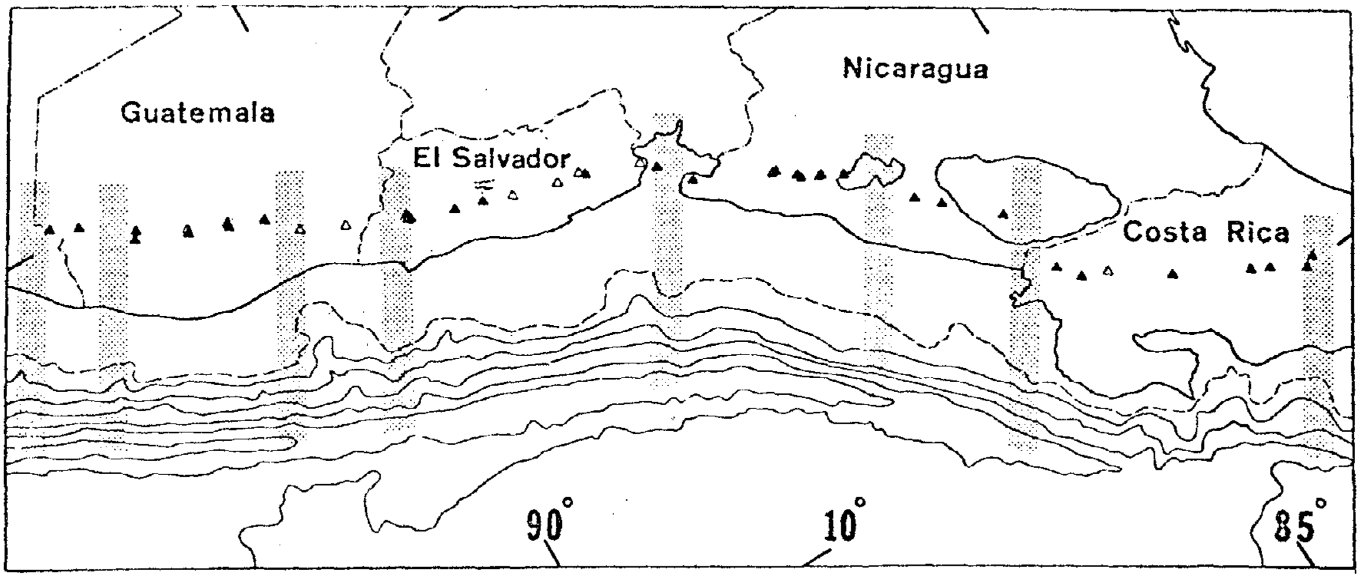
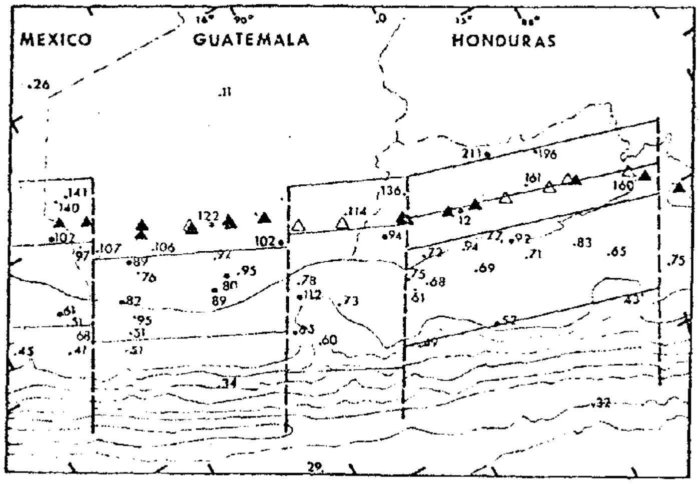


Figure 2-2. Map showing Morphotectonic units and Submarine features of Northern Central America (From Dengo & Bohnenberger, 1969)



Volcanic segments of Central America. Solid triangles are volcanoes with historic eruptions (from Mooser et al. 1958), with the addition of Arenal Volcano in Costa Rica. Open triangles are volcanoes with solfatara activity (from Mooser et al., 1958), with the addition of Moyuta Volcano in southeastern Guatemala and the deletion of Zuñil. Bathymetry is from Fisher (1961): the dashed contour is the 100-fathom contour; the next contour is the 500-fathom interval. Stippled areas represent boundaries between adjacent segments.

(From Carr, Stoiber & Drake, 1974)



Seismicity of northern Central America. Focal depths in kilometres are written next to epicenters (dots). Circled dots are epicenters of 15 earthquakes used in JHD. Dashed lines are proposed discontinuities in the inclined seismic zone. Straight lines are isobaths of the deep seismic zone. Contour interval is 50 km and contour nearest the Middle America Trench is the 50-km contour. Unlabeled country is El Salvador. Solid triangles are volcanoes with historic eruptions, and open triangles are volcanoes with solfatara activity (Stoiber and Carr, 1973). Bathymetry is from Fisher (1961). Contour nearest the coast is the 100-fm contour. Next contour is the 500-fm contour, and subsequent contours have a 500-fm interval.

(From Carr, 1976)

Figure 2-3

Volcanic Ranges and Plateaus:

The Volcanic Ranges and Plateaus, or Volcanic Highlands as described by Williams (1960), form the southern part of Northern Central America, extending across southern Guatemala from the Pacific Volcanic Chain eastward into western Honduras and northern El Salvador (see Figure 2-2). The Tertiary (Miocene to Pliocene, or 25 to one million years old) rocks of the highlands are partly lava flows, ranging from basalt to rhyolite, but are more commonly rhyolitic and dacitic pumice deposits with interbedded fluviatile (river deposited) tuffaceous sediments and a few lenses of diatomite (a deposit formed from silica rich microscopic organisms) (Williams, 1960). Most of these deposits are products of fissure eruptions, rather than of large composite cones, which developed later during Quaternary times. The volcanic deposits overlie a rugged surface cut in mid-Cretaceous plutonic rocks (diorites, granodiorites and granites), early Cretaceous limestones and older metamorphic rocks (serpentinites, mica schists and minor phyllitic shales, marbles, quartzites, and calc-silicate contact rocks).

During and after late Pliocene time, these volcanic deposits were faulted and folded, the trends being generally north-south in the north eastern portion and more northeast-southwest to east-west throughout the rest of the highlands.

Quaternary volcanism consists mainly or wholly of basaltic volcanoes and abundant basaltic cinder cones, occurring as parasitic cones on the flanks of the volcanoes, and as independent features often aligned along faults (Williams, McBirney and Dengo, 1964). Quaternary pumice is relatively scarce, compared to that discharged by the volcanic chain to the west, and to those deposits produced during the period of Tertiary volcanism. The Quaternary volcanoes of this region are widely scattered along fissure systems, often lying on north-south trending faults (Williams, McBirney and Dengo, 1964).

Sierras of Northern Central America:

An arcuate series of subparallel high mountain ranges, convex southward, extends across central Guatemala from Chiapas, Mexico to the Caribbean Sea (see Figure 2-2). The northern ranges of this series appear to be structurally continuous with the submarine topographic high, known as the Cayman Ridge (Dengo and Bohnenberger, 1969). Also the submarine Cayman (Bartlett) trough is continuous structurally with some of the longitudinal valleys which separate several of the mountain ranges, namely the long, narrow fault controlled Polochic and Motagua Valleys.

These mountain ranges can be subdivided, as suggested by Dengo and Bohnenberger (1969) into a northern and a southern group of mountain ranges. The northern group includes the northwest trending Sierra Cuchumatanes, the east-west trending Sierra de Chama and the generally east-northeast trending Sierra de Santa Cruz Range. The Maya Mountains of Belice are also included in this northern group of mountains. The southern group of ranges includes the Sierra de Chuacus, which trends nearly east-west, the east-northeast trending Sierra de las Minas and Sierra de Merendon Ranges and the El Mico Mountains. The Sierra de Santa Cruz and Sierra de las Minas ranges are separated by the Polochic Valley, whereas the Sierra de las Minas and the Sierra de Chuacus are separated from the Sierra de Merendon by the Motagua Valley.

The northern group of mountain ranges are composed primarily of Permian (270 to 220 million years old) and Cretaceous (135 to 70 million years old) limestone which now forms a "series of parallel, tightly folded ranges thrust faulted toward the north and modified by later normal faults" (Dengo and Bohnenberger, 1969) (see Figure 2-4). These thrust faults trend subparallel to the arcuate trend of the mountain ranges and dip to the south. The normal faults are vertical or steeply dipping and often trend approximately north-south, truncating and offsetting the reverse (thrust) faults (Williams, 1960).

Late Cretaceous and Early Tertiary marine clastic sediments of the Sepur formation are preserved in the synclinal troughs and fault controlled valleys of the northern ranges (Bonis, 1967). This formation consists mainly of shales, calcarenites (calcium carbonate rich sandstone) and conglomerates. Pre-Mesozoic sedimentary rocks (sandstone, shale, conglomerate and phyllite of the Santa Rosa Group) are found in the Maya Mountains, and Sierra de los Cuchumatanes, as are Paleozoic metamophic rocks and Jurassic-early Cretaceous continental and marine redbeds (mainly sandstone and conglomerate) of the Todos Santos formation (Bonis, 1967). Ultramafic rocks, predominantly serpentinites, also occur in the northern ranges, making up much of the Sierra de Santa Cruz (Dengo and Bohnenberger, 1969).

To the north the rocks are less intensely folded and thrust faulted, forming an intermediate zone between the main fold belt of the high sierras to the south and the nearly flat lying rocks of the Yucatan Platform to the north. This series of low ranges and intervening lowlands makes up the marginal folded belt (see Figure 2-2).

The southern group of mountain ranges consists primarily of pre-Pennsylvanian (before about 300 million years ago) schists, gneisses, amphibolites and marbles of the Chuacas Series (McBirney, 1963), granitic batholiths and ultramafic rocks, mainly serpentinites. Paleozoic and Mesozoic sedimentary rocks (carbonates, shales, sandstones, conglomerates, and phyllites) occur only locally within these ranges. Within the Motagua

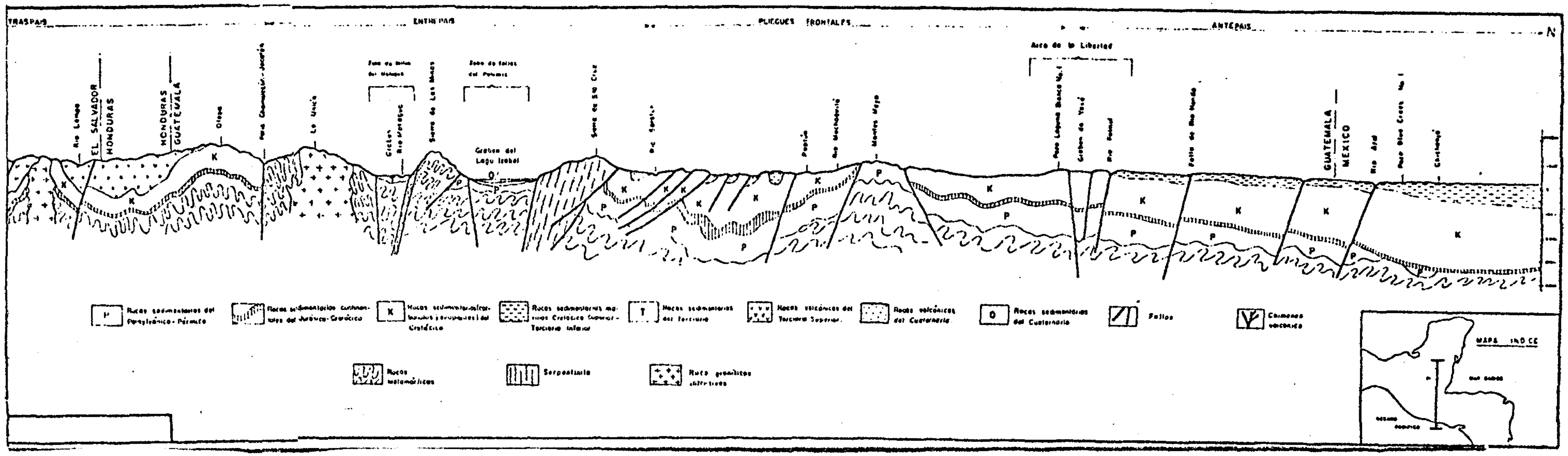


Figure 2-4. Generalized geologic cross section through Guatemala, showing the different surface and subsurface rock units and the major structures. (From Dengo, 1968)

Valley, and bounded by the Motagua fault system are Cretaceous to Eocene (135 to 40 million years old) and redbeds of the Subinal formation. Also within the Motagua Valley, and other intervening valleys, are small areas of Quaternary pumice deposits.

The faulting in the southern group of mountain ranges is less dominated by east-west trending, south dipping thrust faults, but rather by a few major left lateral strike-slip faults, namely the Cuilco-Chixoy-Polochic fault, the Motagua fault and the Jocotan-Chamelecon fault to the south.

Yucatan Platform:

The Yucatan Platform, or Peten Lowland (Bonis, 1967) extends across northern Guatemala from Tabasco, Mexico into northern Belice (see Figure 2-2). The southern limit of the Yucatan Platform is marked by the La Libertad Arch, (Vinson and Brineman, 1961). Nearly flat lying Paleozoic and Eocene marine sediments cover much of the northern portion of the area, overlying Cretaceous carbonate and evaporite rocks, which crop out extensively in the southern part of the Yucatan Platform.

An extensive karst topography has developed on the carbonate rocks, including underground drainages and large caverns. Collapse of these caverns has produced earthquakes which commonly have shallow epicenters and fairly local felt areas (Lomnitz, 1974).

II-3 Volcanic Activity:

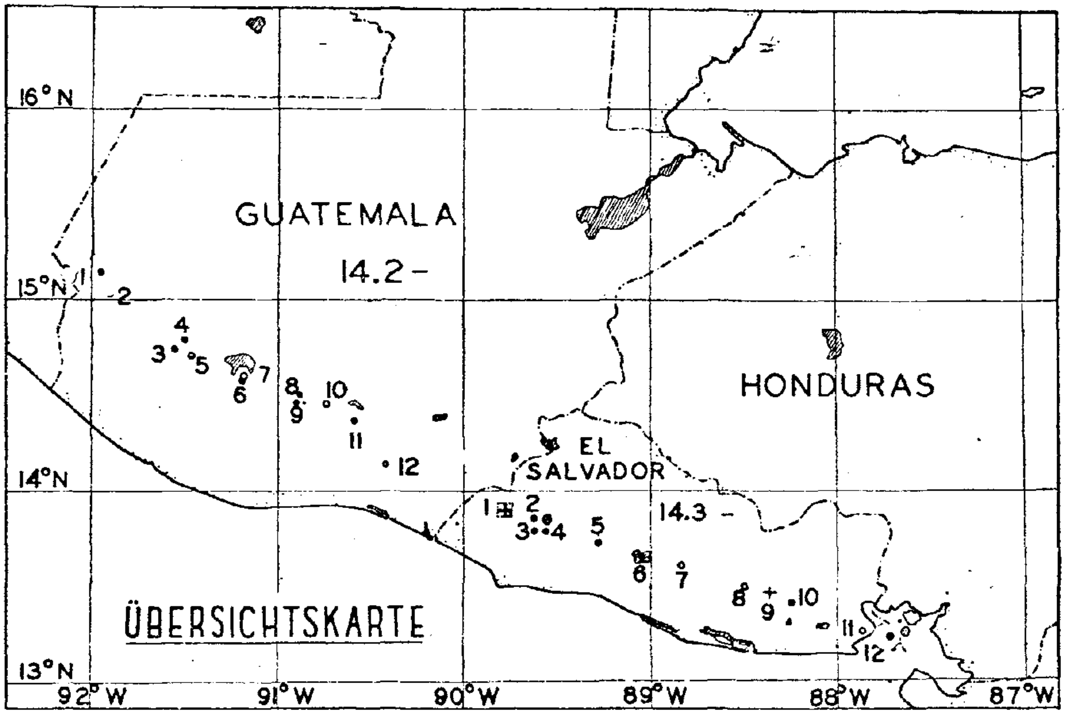
Quaternary volcanic activity is restricted to the southern part of the country, occurring along the Pacific Volcanic Chain and in the Volcanic Ranges and Plateaus region, east of the main chain. The types of Quaternary deposits include andesitic and basaltic flows, and pumice deposits laid down by torrential floods which removed airborne pumice falls from the surrounding hills, and less commonly the product of glowing avalanches.

The principal group of volcanoes in Guatemala (see Figure 2-5) lie in a nearly straight line for 122 kilometers from Volcano Siete Orejas to Volcano Pacaya, at which point the line splits with one strand to the north linking the twin volcanoes of Lake Ayarza, the other strand, offset several kilometers to the south, links volcano Tecuamburo and Volcano Moyota. To the north, near the Guatemala-Mexico border, lie Volcan Tacána and Volcano Tajumulco, which are offset to the north of the main chain. Near the Guatemala-El Salvador border, the cones are more widely scattered and irregularly distributed.

Activity within the past few centuries has been recorded from several volcanoes. Cerro Quemado, south of Quetzaltenango, erupted most recently in 1785 with fumerolic activity noted by recent investigators. In 1853, Volcano Atitlan, south of Lake Atitlan, erupted. This volcano had had prior periods of explosive activity, however, no recent eruptions have been recorded. Volcano Pacaya, located south of Guatemala City has been intermittently active over the last several hundred years. The two most active volcanoes in Guatemala are Volcano Fuego, nearly 40 kilometers southwest of Guatemala City, and Santiaguito on the southern flank of Volcano Santa Maria, about eight kilometers south of Quetzaltenango. Both of these volcanoes have continued to show signs of activity up to the present. The basaltic cinder cones and related flows of eastern Guatemala are thought to be no more than a few thousand years old (Williams, 1960).

II-4 Faulting:

Guatemala can be subdivided into three major structural regions, each characterized by different types, orientations and intensities of faulting and folding. These regions generally coincide with some of the



Index map showing the sites of the volcanic centres of Guatemala and El Salvador.

Figure 2-5.

1. Tacaná
2. Tajumulco
3. Santa Maria
4. Cerro Quemado
5. Zuñil
6. Atitlán
7. Toliman
8. Acatenango
9. Fuego
10. Agua
11. Pacaya
12. Tecuamburro

major morphotectonic subdivisions of Dengo and Bohnenberger (1969), and include: the south dipping thrust faults and normal faults of the northern group of mountain ranges and the Yucatan Platform; the east-west longitudinal strike-slip faults of the southern group of mountain ranges; and the normal and transcurrent fault zones of the Volcanic Ranges and Plateaus and Pacific Volcanic Chain. This transcurrent fault zone includes N30-45°E trending left lateral strike-slip faults, a conjugate set of N45-65°W trending normal and right lateral strike-slip faults, plus a set of normal (extensional) faults trending generally north-south. These various regions, and their fault zones, may be the result of different stress systems operating at different times, or one stress system of very large dimensions, portions of which have been active at different times (Dengo and Bohnenberg, 1969).

The northern system of thrust faults and subsequent normal faults are thought to be of late Cretaceous and Tertiary age. The thrust faulting began during late Cretaceous times and climaxed in early Eocene time. Uplift of the Yucatan Platform and adjacent regions took place during late Eocene and Oligocene times (50 to 25 million years ago). The normal faulting is thought to have occurred during this period of uplift. Present day earthquakes in this region are more commonly due to limestone cavern collapse, as previously mentioned, rather than of tectonic origin (Lomnitz, 1974).

The arcuate (convex southward) generally east-west trending longitudinal faults of the southern mountain group make up the second subdivision. This includes from north to south, the Cuilco-Chixoy-Polochic fault zone, the Motagua fault zone and the Jocotan-Chamelecon fault zone (see Figure 2-6). The Polochic fault zone extends from the Caribbean Sea to west of the Guatemala-Mexico border, stretching nearly 400

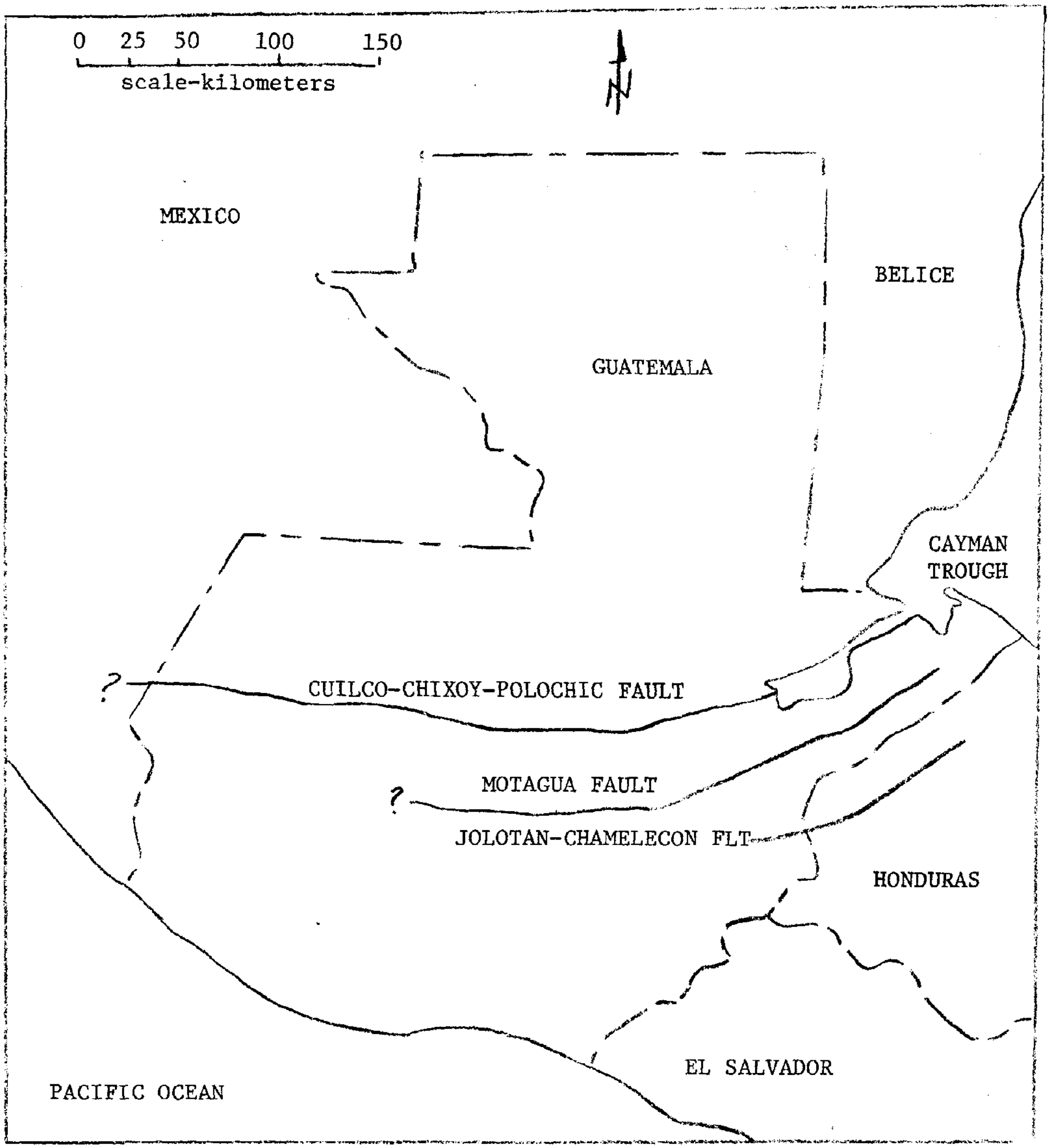


Figure 2-6. Map of Guatemala, showing the locations of the major longitudinal fault zones. (Modified from Anderson and others, 1973)

kilometers, whereas the Motagua fault zone extends from near the Caribbean Sea to the west nearly 300 kilometers. The western extent of the Motagua fault is uncertain because Quaternary volcanic deposits of the Pacific volcanic belt conceal the fault trace (Anderson, 1973; Dengo and Bohnenberger, 1969). The Jocotan-Chamelecon fault zone trends generally northeast-southwest, subparallel to the eastern half of the Motagua fault zone, and extends across northern Honduras into eastern Guatemala, a distance of 125 kilometers. The Motagua and Polochic faults are the landward projection of the Cayman trough, a deep submarine trough which marks the northwest boundary of the Caribbean Plate, as mentioned previously (see Figure 2-1).

Until recently, movements along the Cuilco-Chixoy-Polochic, Motagua and Jocotan-Chamelecon fault zones were thought to be in the vertical direction, with only minor left lateral displacement, based on geologic field evidence in Guatemala. However, many investigators are now postulating large magnitude left lateral strike-slip faulting along these fault zones, suggested by the linearity and width of the fault zones, offset streams, geomorphic features such as beheaded valleys, shutter ridges and chains of scarplets (Kupfer and Godoy, 1967) and a series of inverted open S-shaped folds in Late Tertiary sediments deposited in the Polochic fault zone, which show drag features close to the faults (Dengo and Bohnenberger, 1969). Left lateral transcurrent faulting is further supported by the modern plate tectonics model for this area, earthquake focal mechanism studies (Molnar and Sykes, 1969), and by the displacements observed along the Motagua fault zone following the 1976 Guatemala earthquake (Plafker & Bonilla, 1976).

Recent activity along these major faults is indicated by the abundance of fault scarps and offsets of recent geomorphic features, as well as the occurrence of earthquakes with epicenters along the faults. A more complete discussion of the 1976 rupture along the Motagua fault is given in Appendix C.

Quaternary faulting in the third region includes three major fault trends; transcurrent N30-45°E faults, right lateral and normal N45-65°W faults, and generally north-south extensional faults (Carr, 1976). These faults are most readily observed in the Volcanic Ranges and Plateaus region of Figure 2.

The two major left lateral, northeast trending faults of this region, as described by Carr (1976), are the Palin Shear Zone and the Rio Paz Shear Zone, about 75 kilometers to the southeast of the Palin Shear Zone. Carr suggests a relationship between these left lateral faults and the segmentation of the volcanic chain to discontinuities in the inclined seismic zone, or Benioff Zone (Carr, 1976).

The northwest trending faults may be a conjugate system to the northeast trending faults. Carr (1976) suggests that they often have right lateral motion, however, many also show a component of normal displacement (vertical movement) (Williams, McBirney and Dengo, 1964). One example of these faults is the Median Trough in El Salvador. The Jalapatagua fault of southeastern Guatemala, southeast of Guatemala City, exhibits right lateral strike-slip motion. Northwest trending faults have also been noted to be associated with, and in close proximity to, the volcanic chain of the Pacific.

The third principal fault orientation of this region is in the north-south direction. These faults are primarily normal faults, producing north-south trending grabens (down-dropped blocks), such as the Guatemala City and Ipala grabens. These faults also tend to control the distribution of Quaternary volcanics. These north-south trending faults become much more dominant in the northern and northeastern portion of the Volcanic Ranges and Plateaus unit, whereas to the south, all three fault trends occur together.

All three fault trends of this southern region show signs of recent activity, based on geomorphic evidence and the cross cutting relationships of the various faults. Recent activity along the north-south faults is demonstrated by the occurrence of north-south trending scarps offsetting Quaternary pumice deposits and fresh cinder cones (Dengo and Bohnenberger, 1969). The Mixco fault (see Figure 2-7), west of Guatemala City, exhibited dip-slip movement (Plafker & Bonilla, 1976) in association with the February 4, 1976 Guatemala earthquake, further supporting that the north-south trend is still active (Appendix C).

Seismic zoning, based on a thorough understanding of the nature of faulting, the tectonic history and present day regime, and other critical factors, is essential for safe growth in a seismically active region, such as Guatemala. A few important points relating to seismic zoning follow:

1. Numerous active and potentially active faults are observable in Guatemala, as described above. Recognition of these active faults is not as difficult in Guatemala as in other countries, because of the abundance of Quaternary volcanic deposits (for dating the faulting), and the existence and preservation of geomorphic features such as fault scarps, fault valleys, etc., as well as other factors. Not all of the active faults ruptured during the 1976 Guatemala earthquake. Therefore, in seismic zoning, all of the active faults should be considered capable of rupturing during future earthquakes, except where specific studies suggest otherwise.

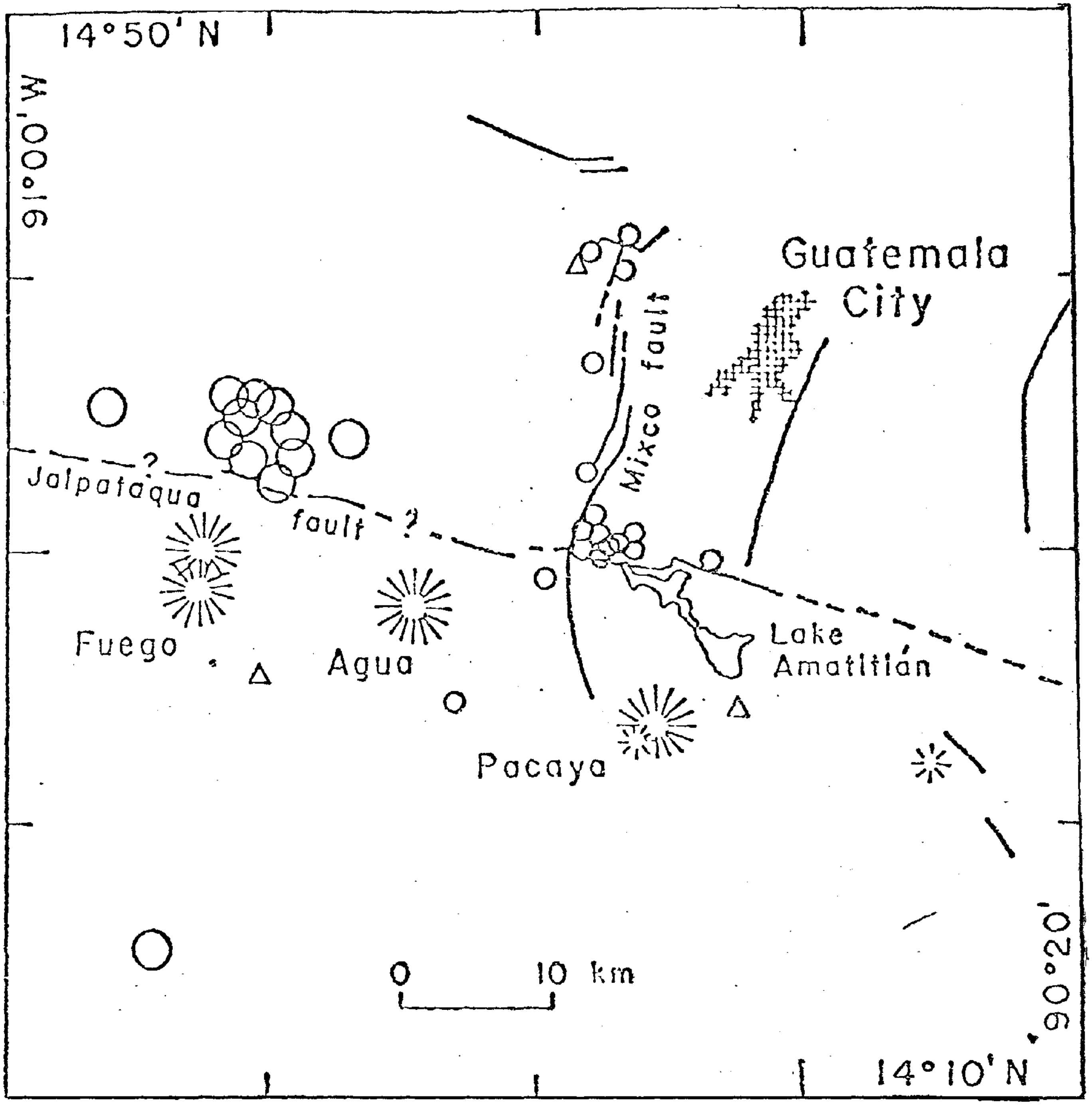


Figure 2-7. Location of Mixco Fault. Open circles are epicenter locations from 1973-1974. The size of the circles reflects the estimated error in the calculated location.

2. It should be noted, as was observed during the 1976 Guatemala earthquake, that several apparently unrelated faults can rupture and/or show other signs of activity during a single event. Therefore, recognition of more than the dominant orientation of active faulting is necessary for safe seismic zoning.

3. The definition of an "active" fault is not yet agreed upon. The number of years since the most recent movement along the fault, before it can be considered "inactive", is still unresolved. Many geologists use 40,000 years since the last movement as the criterion of "active". The valid argument has been made that even 10,000 years or less is economically impractical when considering structures with an anticipated lifetime of less than 100 years. A definition developed by Nichols and Buchanan-Banks (1974) is that "faults are regarded as active and of concern to land-use planning when there is evidence that they have moved during historic time or, through geologic evidence, there is a significant likelihood that they will move during the projected use of a particular structure or piece of land". An understanding of the recurrence interval and nature of faulting is necessary in selecting a minimum age since the most recent movement. However, it is our opinion that strategically important and large public structures should not be located over defined faults, unless the most conservative (40,000 years) definition of "active" is used.

4. The faults that are designated as "active" should be considered as zones, rather than a line of movement. It has been observed that certain faults (such as the San Andreas fault in California) tend to rupture repeatedly along nearly the same line (Nichols and Buchanan-Banks, 1974). However, in some regions many recent fault scarps are located

within wider fault zones; while in alluvium, the fault rupture could occur outward from the previously "recognized" break. The width of this "zone" depends on the nature of the faulting, the orientation of the fault plane, and the materials being faulted, along with several other factors. Once the fault zone can be reliably delineated, it is our opinion that at least the vital structures, such as hospitals, police and fire stations, etc., should be located at least 30 to 45 meters from these fault zones.

5. The type of material on which the structure rests, and the degree of saturation of the material are extremely important.

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CHAPTER III

SEISMIC DATA BASE

Scope

This chapter describes the available seismological data for the country. Its characteristics and limitations are discussed. Based on the fault locations, eighteen line sources are modeled, their seismicity determined and the confidence on the recurrence relationship presented.

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III-1 Introduction

A difficult but essential task for the current study is the acquisition of past earthquake data. In general it is necessary for the data to contain information on the severity of the earthquake, the epicentral location, the focal depth to the hypocenter, and the time of occurrence.

The most commonly used parameters representing the severity of the seismic events are the Modified Mercalli intensity, the Richter magnitude and the peak ground acceleration. The Modified Mercalli intensity is a subjective scale of the damage at a site. Forecasting of MM intensities can be useful in determining the future damage potential in a region, however they cannot be related to structural response characteristics for analysis and design purposes. Thus, in the present study MM intensity data will be used only when it can be translated into either a Richter magnitude or a peak ground acceleration.

The Richter magnitude is related to the overall energy release of a seismic event. It is important to note that the Richter magnitude conveys information only at the epicenter (or hypocenter). The parameter popular among earthquake engineers which represents the ground motion at a site is the peak ground acceleration. It is frequently used for analysis and design of structures, consequently it will be employed in the present report as the parameter for determining the "seismic loads" at a site. Recently other load measuring parameters such as root-mean-square of ground motion, stress drop, and seismic moment have become popular among seismologists and engineers. However these parameters have been determined only for a few past earthquake events and thus cannot be used in the present study.

In addition to the above specified characteristics of the data base, it is desirable to have strong motion accelerograph records from major earthquakes and also information on how the energy (or the peak ground acceleration) attenuates from the source to the site. Only a few accelerograms of very low acceleration amplitudes are available for the country and hence are hardly sufficient for determining the attenuation characteristics in Guatemala.

Before carrying the discussion further into the analysis and use of the available data certain observations should be made regarding the type, the amount and the reliability of the data base used in the current work.

A shortcoming common to all the data sources is that the frequency of recorded earthquakes increases with time, (i.e. the number of seismic events recorded increases with each year). This nonhomogeneity in the data base is due not because there is necessarily an increase in the seismic activity in the region, but because of the improvement of instruments, measurements and measurement analysis techniques resulting in a bias towards recent years. This non-uniformity in the data can be observed to be true for all historical-time-dependent records and is a "fact of life." Thus one cannot get away from it.

The other problems associated with the data base deal specifically with the variability of the epicentral location, the Richter magnitude and the focal depth. Variations in epicentral location are dependent on the seismological station reporting the earthquakes. For earlier seismic events only the general region of the earthquake occurrence is reported where on occasions it encircles an area of 100 km radius. Furthermore, for many of these events the focal depth is not determined due to lack of seismograph records close to the epicenter. In cases where a focal depth is reported, its reliability can also be questioned. Similarly, the value of Richter magnitude is not always recorded and when recorded it contains certain error. The variability of the data and its effect on the modeling has been extensively studied (Kiremidjian and Shah, 1975) previously. An assessment of the uncertainties of the data associated with the present study will be made at the end of this report.

III-2 Data Analysis

Past earthquake data was collected for a region spanning from 12.5°N to 19.5°N and from 86.5°W to 93.5°W. These boundaries are chosen so that they are at least one degree (longitude or latitude) outside of the border of Guatemala. The two main sources of information that are considered for data acquisition are:

- The NEIC-NOAA data file containing events from January 1900 to August 1973 and referred to hereafter as Data File 1;
- The Preliminary Data Epicenters of the NEIC-USGS covering the period from September 1973 to February 1976, and referred to hereafter as Data File 2.

In addition, the events reported by the Bulletin of the Seismological Society of America and the Observatorio Meteorologica Nacional of

Guatemala were used to check the completeness of the data. Information on the major shock of the February 4, 1976 earthquake and its aftershocks was obtained from the United States Geological Survey (Page ed., 1976) and records of the Observatorio Meteorologico Nacional. In spite of the complementarity of the different data sources, a large number of events remain insufficiently documented in order to be used as such in the analysis. Thus in cases where basic information such as epicentral location or magnitude is missing, the event is disregarded. Records with a Richter magnitude smaller than 3.0 are also not considered.

Both Date Files 1 and 2 are very similar thus they will be discussed together. When complete, the information for a given seismic event contained in these files includes the time of occurrence, the epicentral location (degrees longitude and latitude), the depth to the hypocenter (km), and the magnitude. The magnitude is given in terms of one of the following:

(1) CGS M_b average (body wave magnitude)

(2) CGS M_s average (surface wave magnitude)

(3) Richter magnitude M.

For the study at hand, it is necessary that all the data be expressed in terms of a single magnitude parameter. The Richter magnitude is chosen for that purpose and whenever only M_b values are reported these values are converted to Richter magnitude. It is known that for a given part of the world, the Richter magnitude and CGS M_b are linearly related such that

$$M = a + b\, M_b \qquad 3\text{-}1$$

In order to determine the coefficients a and b, a regression analysis was performed for all earthquakes of which M and M_b were known using the total data of Central America. The Richter magnitude was then obtained by substituting the value of M_b in Equation 3-1.

The focal depth given in these files is expressed either in kilometers or by a letter symbol N (0 - 33 km).

From Data File 1, 979 events were reported and from Data File 2, 174 events were obtained, thus constituting a total sample of 1153 past earthquake records containing complete information. The epicenters and the magnitudes of these events are shown on Chart 1. Table 3-1 lists these records as a function of focal depths. A listing of all the data appears in Appendix D.

The general seismic pattern of Guatemala is studied from Charts 1 to 6. The country is divided into the following regions of tectonic activity:

(1) The Benioff Zone dipping northeast under the Guatemalan coast. This zone is marked by a numerous earthquakes covering the entire range of magnitudes. It extends several hundred kilometers beneath the earth's surface. Some of the deepest earthquakes recorded along the Benioff Zone go as far as 299 km projecting around the central portion of the country. The Benioff Zone in this part of the Central Americas has been observed (Carr, 1976) to start out with an extended shallow section and then dip at about 40° angle under the coast of the country. This observation is confirmed by looking at Charts 2 to 6. The range of shallow epicenters extends from the Middle American trench almost to the coastline forming a rather diffused zone.

(2) The Motagua and Polochic fault zones are associated with and extend into the Cayman (Bartlett) trough. In this region of the country primarily shallow earthquakes are observed (5 - 33 km) and the magnitudes are found up to 7.5 on the Richter scale. However, due to the lengths of these

TABLE 3-1

Earthquake Data Sorted According to Depth of Hypocenter

Number of Earthquakes	Depth Range (km)
81	0 - 9
37	10 - 19
34	20 - 29
298	30 - 39
53	40 - 49
65	50 - 59
116	60 - 69
87	70 - 79
72	80 - 89
60	90 - 99
63	100 - 109
39	110 - 119
27	120 - 129
18	130 - 139
13	140 - 149
18	150 - 159
11	160 - 169
8	170 - 179
6	180 - 189
10	190 - 199
20	200 - 219
7	220 - 239
5	240 - 259
4	260 - 279
1	280 - 299

fault zones a maximum magnitude of 8.5 is believed to be possible on either of them. This information is directly incorporated in the seismic modeling of the country (see Table 3-2). These faults are of particular importance because of their capability for large magnitude earthquakes, their shallowness and their proximity to highly populated areas. A smaller, but still important fault that can be linked with these zones is the Jocotan. Its characteristics were already discussed in Chapter II.

(3) The line of volcanoes from northwest to southeast (Cordillera de los Marrabios) represents sources of future seismic activities. Volcanic eruptions are seldom by themselves sources of seismic activity, and in the past various earthquakes have been recorded preceding volcanic eruptions. For this reason earthquakes "associated" with volcanic activity were treated in the model (Chapter II) as shallow tectonic earthquakes.

(4) Several shallow and short faults have been found in the vicinity of Guatemala City of which the Mixco has been observed to have the most recent movement. Their geologic characteristics differ from the major fault zones considered (see Chapter II). Only a few earthquakes have been associated with the Mixco fault, but their severity is of particular concern because of its nearness to Guatemala City.

(5) The Yucatan Platform is observed to have a very low seismicity. In this region no earthquakes of tectonic origin have been recorded.

III-3 Source Location and Seismicity

Based on the above observations, the total number of events was divided into 18 seismic line sources. Table 3-2 identifies the sources, the number of events and the focal depth range for each source. Charts 2 to 6 show the epicenters of past earthquakes associated with each source. Most of the sources are composed of several line segments in

TABLE 3-2

Seismic Sources For Guatemala

SOURCE	NUMBER OF EVENTS	NAME OF SOURCE	DEPTH (km)
S1	56	Motagua	33
S2	16	Polochic	40
S3	31	Line of Volcanoes	30
S4	67	Pacific Coastline	30
S5	19	Pacific Coastline	34
S6	5	Near Mexico Border	30
S7	7	Near Mexico Border	35
S8	16	Mixco	30
S9	17	"Mexico"	60
S10	10	"Mexico"	75
S11	7	Jocotan	30
S12 - B1	244	Benioff 1	30
S13 - B2	87	Benioff 2	50
S14 - B3	192	Benioff 3	70
S15 - B4	196	Benioff 4	90
S16 - B5	111	Benioff 5	130
S17 - B6	35	Benioff 6	180
S18 - B7	37	Benioff 7	225

order that they fit the curvature of a given fault zone. Appendix D gives a listing of the earthquakes included in each source. The depth of each source was computed as an average hypocentral depth of all events included in the sources. Earthquakes with no or limited information were not included in this averaging process. However, they were considered in determining the location and the seismicity of the sources.

The recurrence relationship for each individual source was obtained by fitting a regression line through the data for that source and obtaining

$$\ln N(M) = \alpha + \beta M \qquad 3\text{-}2$$

where $N(M)$ = Number of events above magnitude M

M = Richter magnitude

α and β are regression constants.

α is a measure of the number of events above magnitude 0 for a given source and β is a measure of the seismic severity for a given source. The larger the negative value of β, the smaller the seismic severity. For many sources, a single regression line gave erroneous results because the interpolation of the line beyone the range of data indicated unreasonably high magnitude occurrences. For such cases, two regression lines were fitted to the data, and a geologically consistent upper magnitude value was used for cutoff. (See Figures 3-1 through 3-18.) Table 3-3 gives a summary of α' and β values for each source and the magnitude cutoff point for each source.

$$\text{Let } N'(M) = \frac{N(M)}{AT} \text{ for an area source} \qquad 3\text{-}3a$$

$$= \frac{N(M)}{LT} \text{ for a line source} \qquad 3\text{-}3b$$

where L = Length of the line source

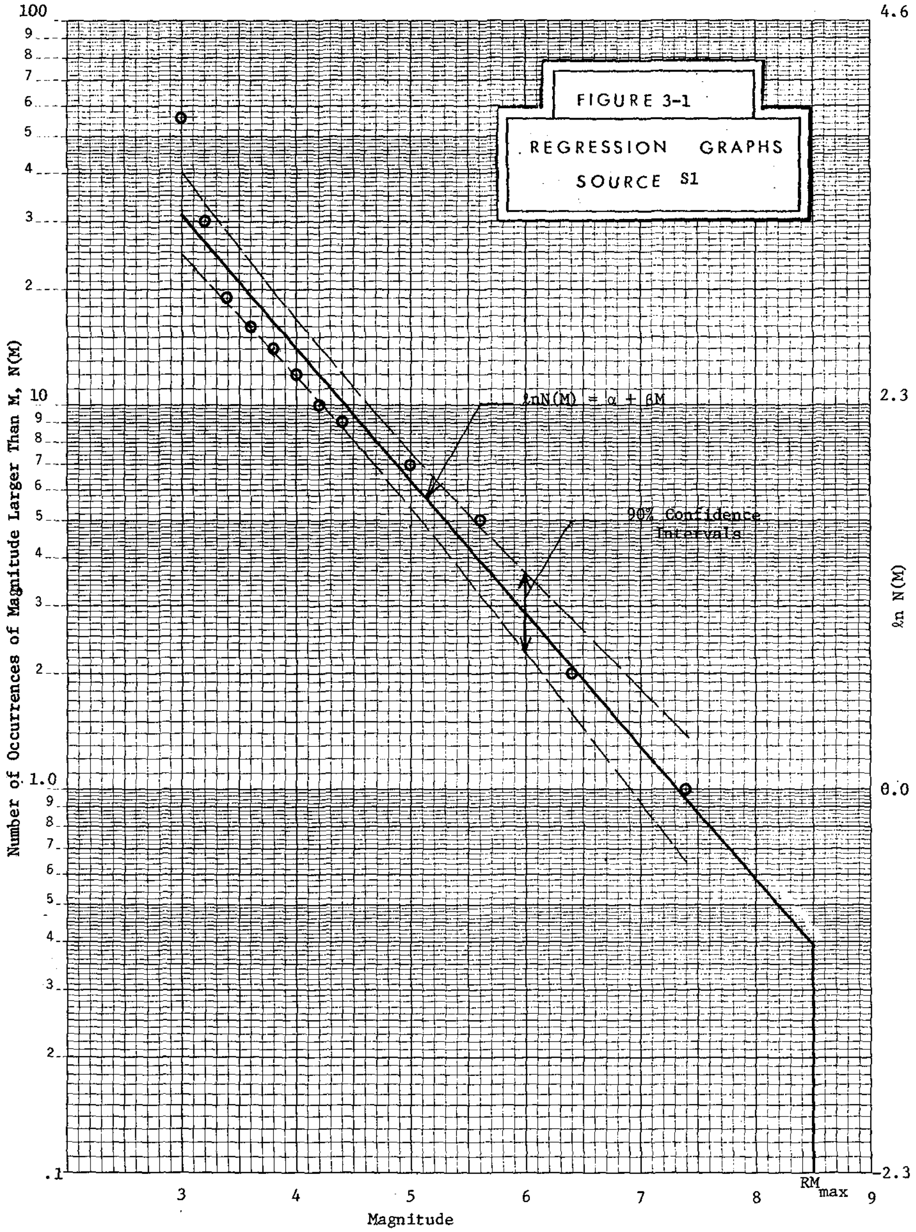


FIGURE 3-1

REGRESSION GRAPHS

SOURCE S1

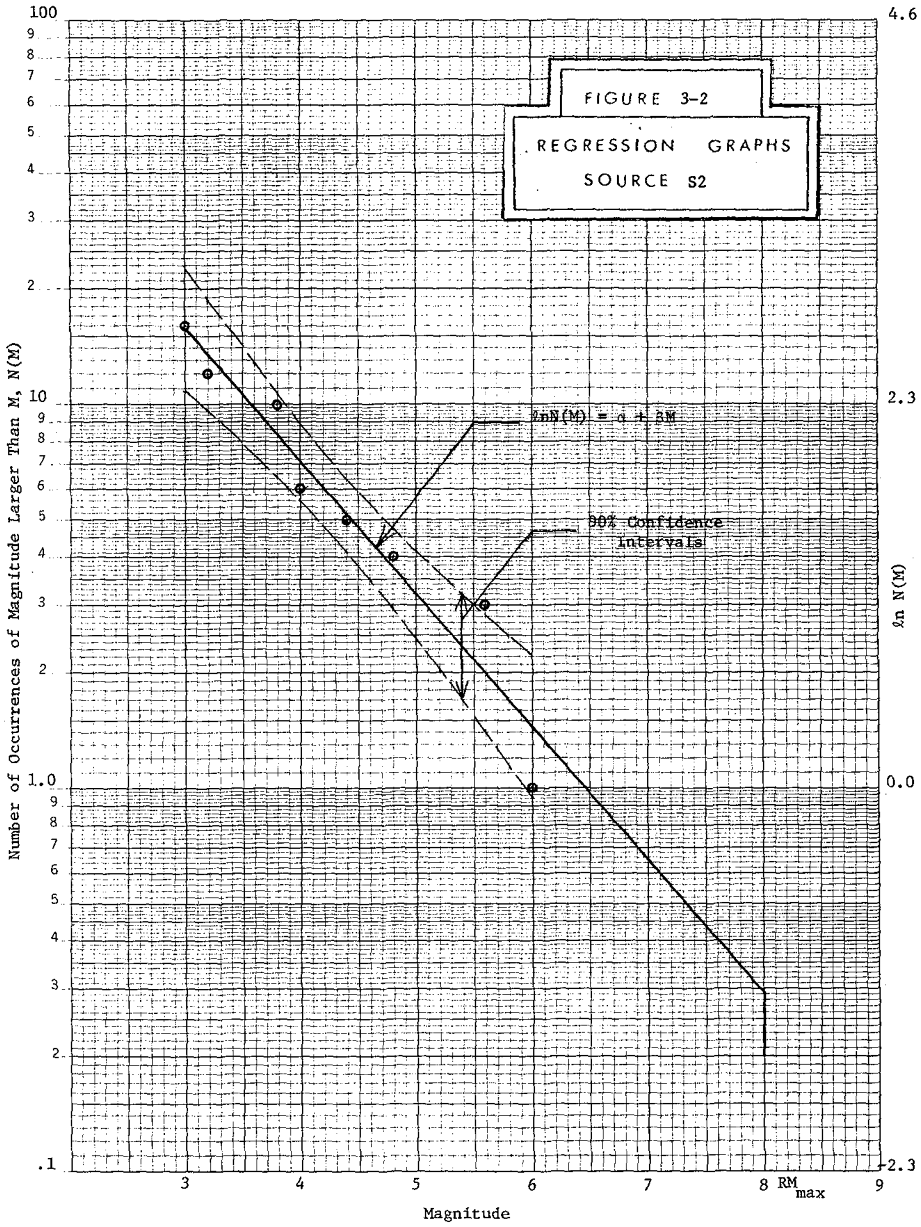


FIGURE 3-2

REGRESSION GRAPHS

SOURCE S2

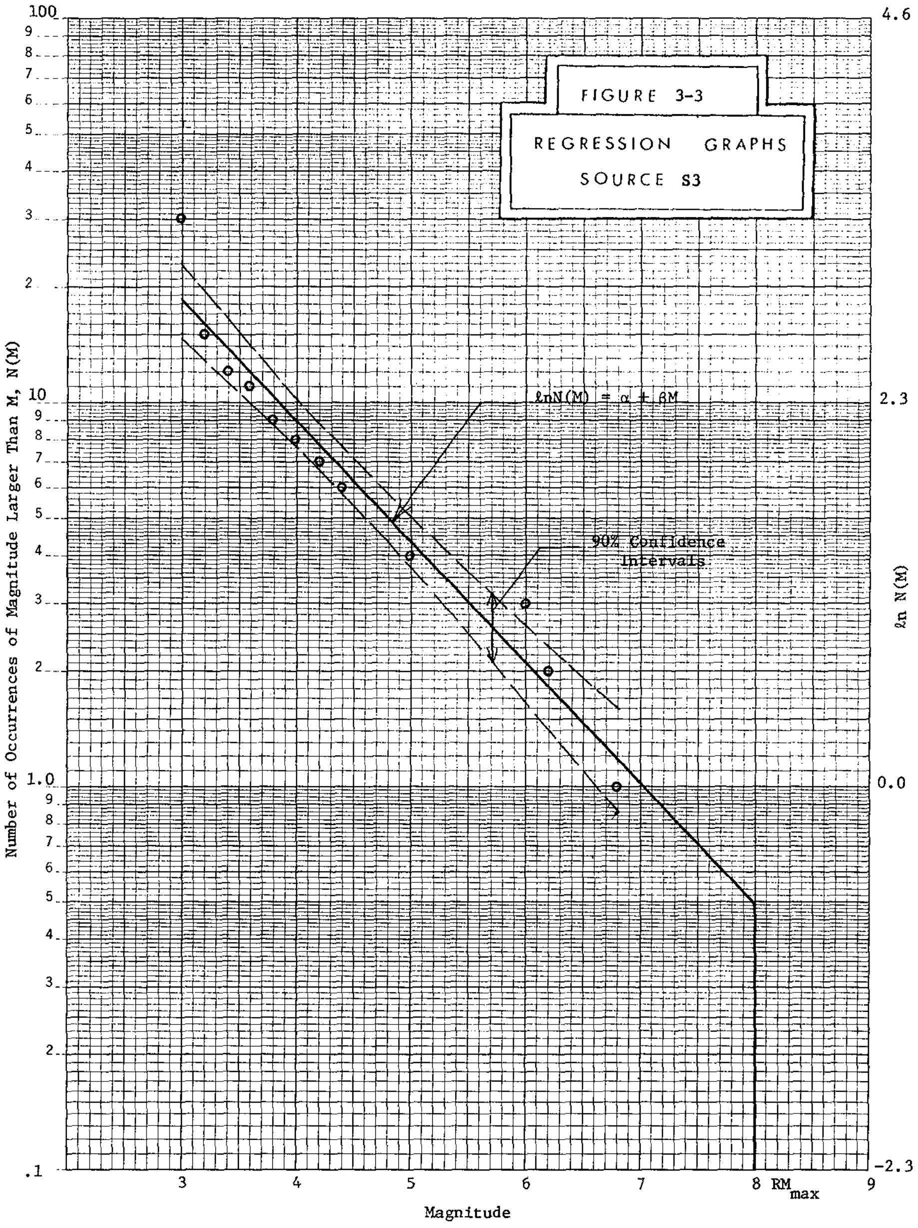


FIGURE 3-3

REGRESSION GRAPHS
SOURCE S3

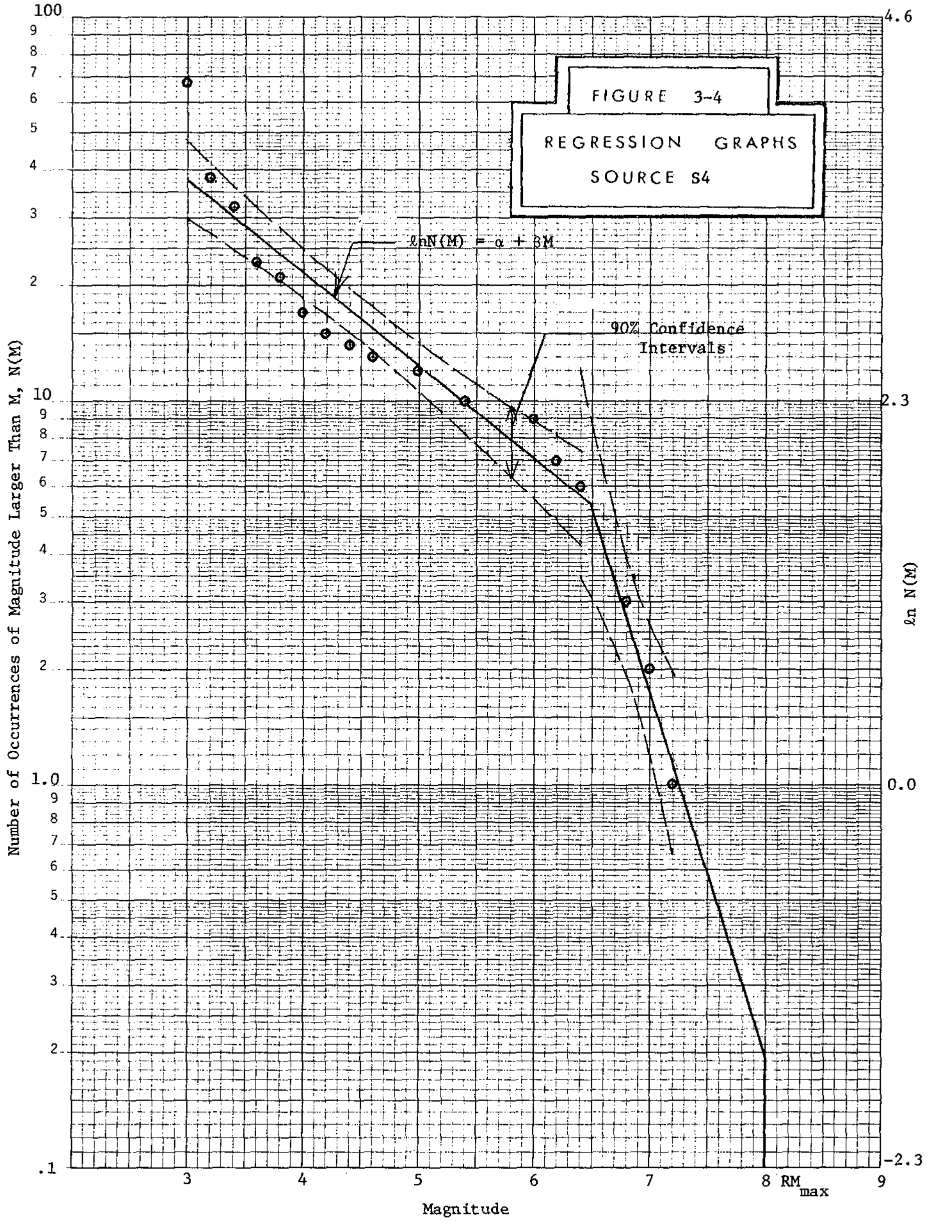


FIGURE 3-4

REGRESSION GRAPHS
SOURCE S4

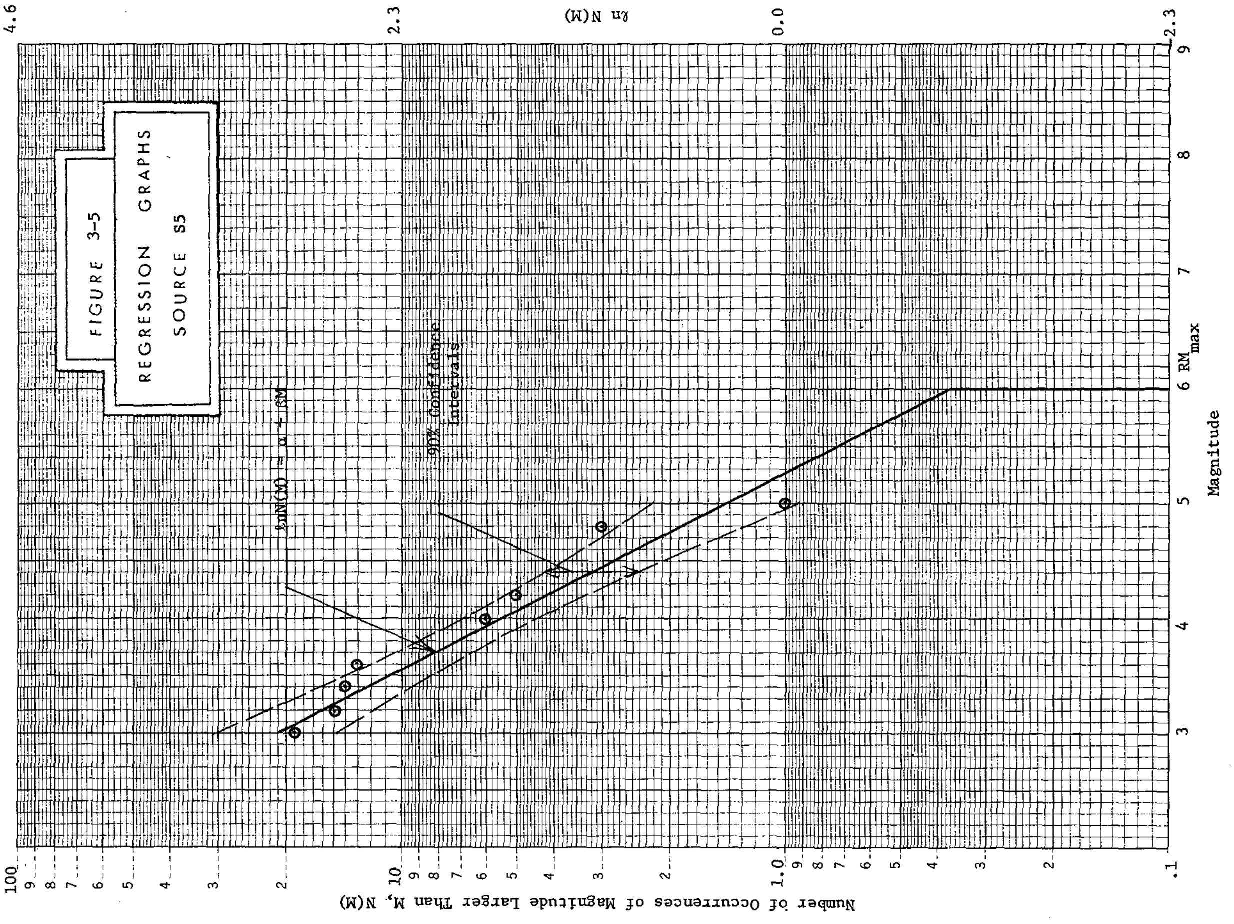


FIGURE 3-5

REGRESSION GRAPHS

SOURCE S5

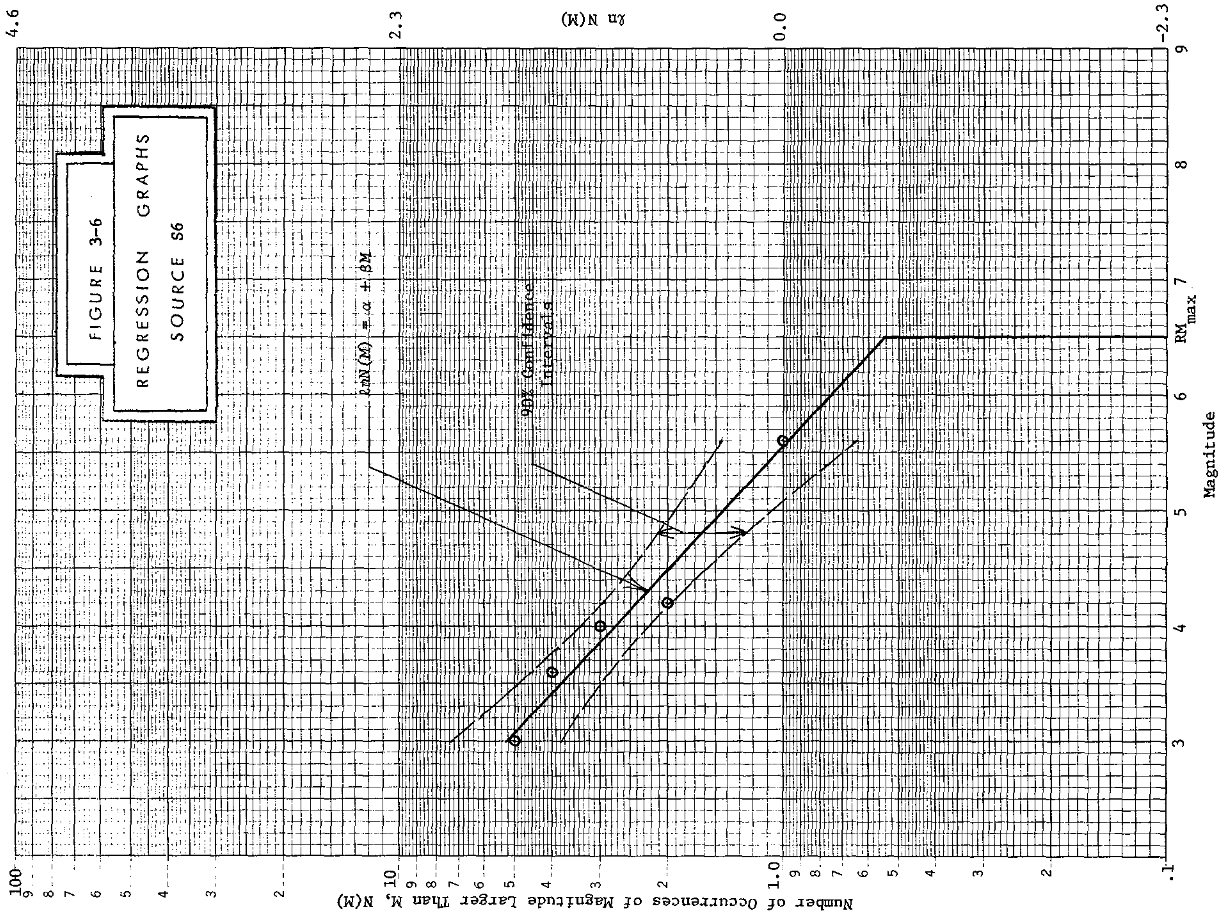


FIGURE 3-6

REGRESSION GRAPHS

SOURCE S6

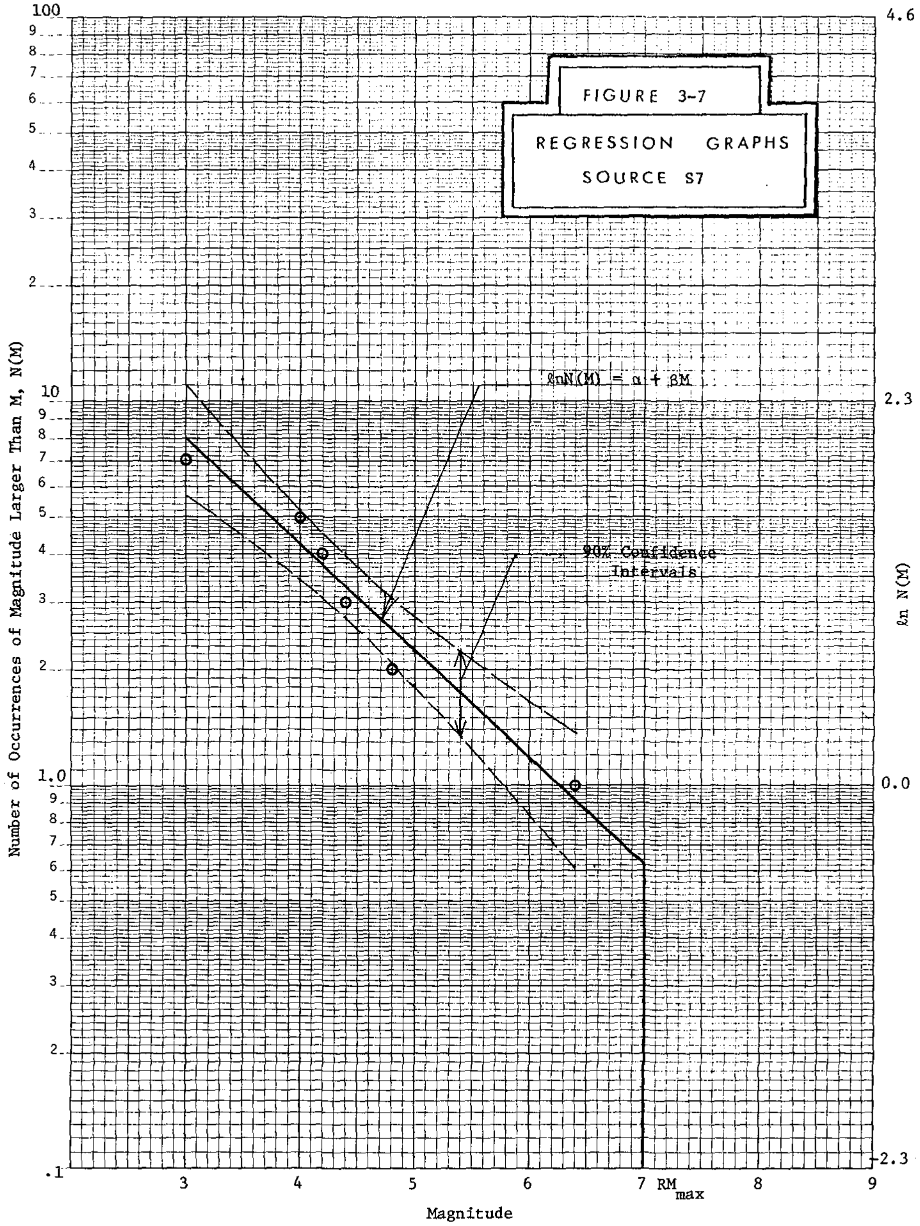


FIGURE 3-7

REGRESSION GRAPHS
SOURCE S7

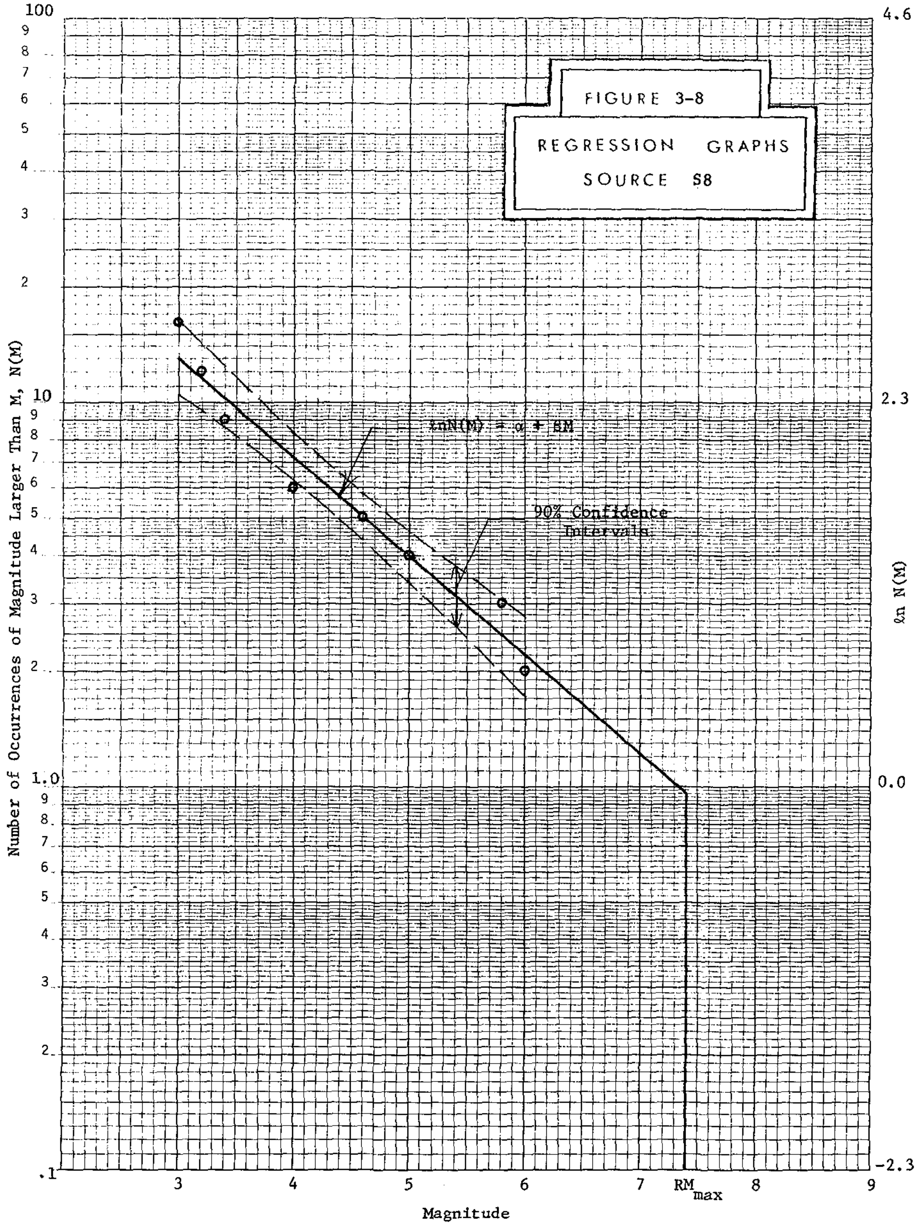


FIGURE 3-8

REGRESSION GRAPHS
SOURCE S8

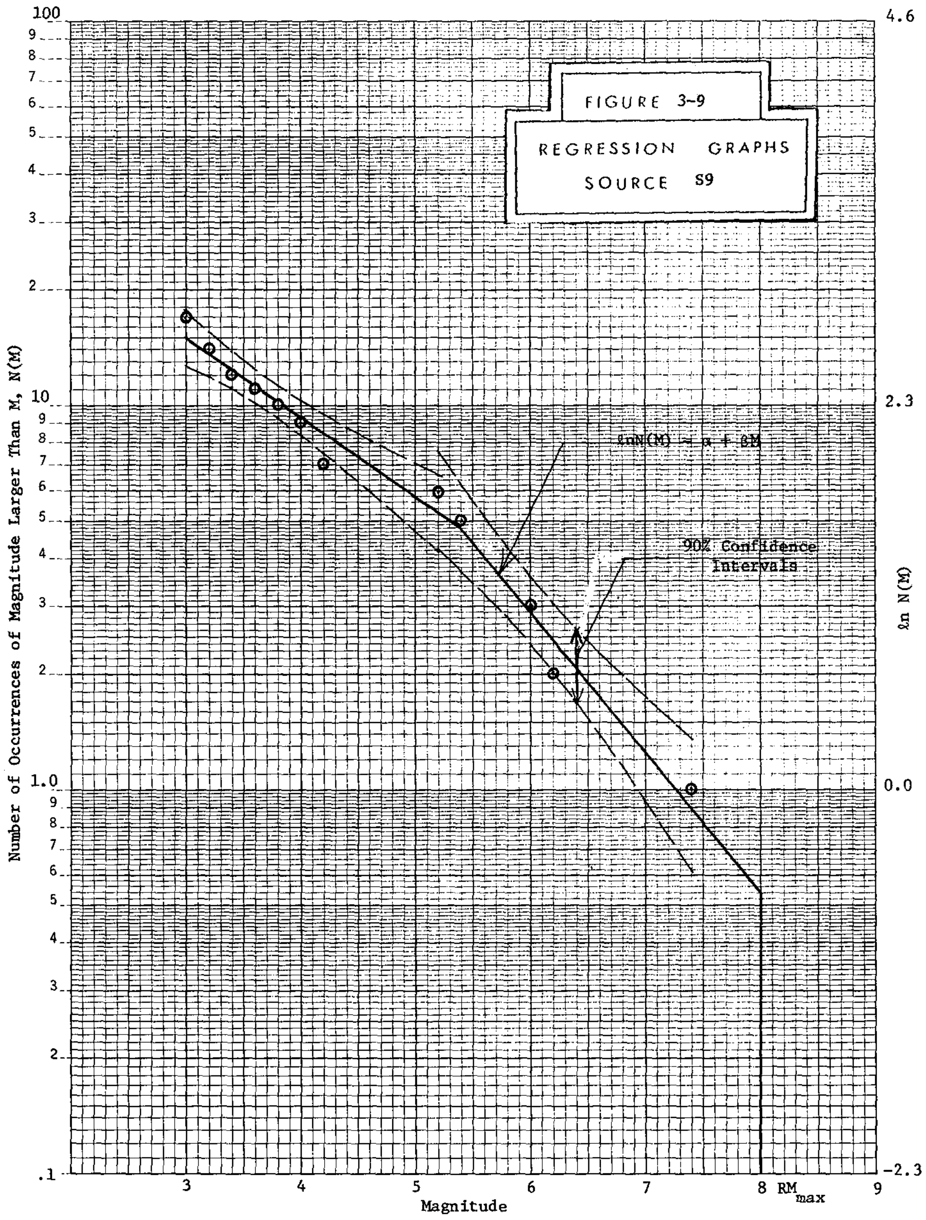


FIGURE 3-9

REGRESSION GRAPHS

SOURCE S9

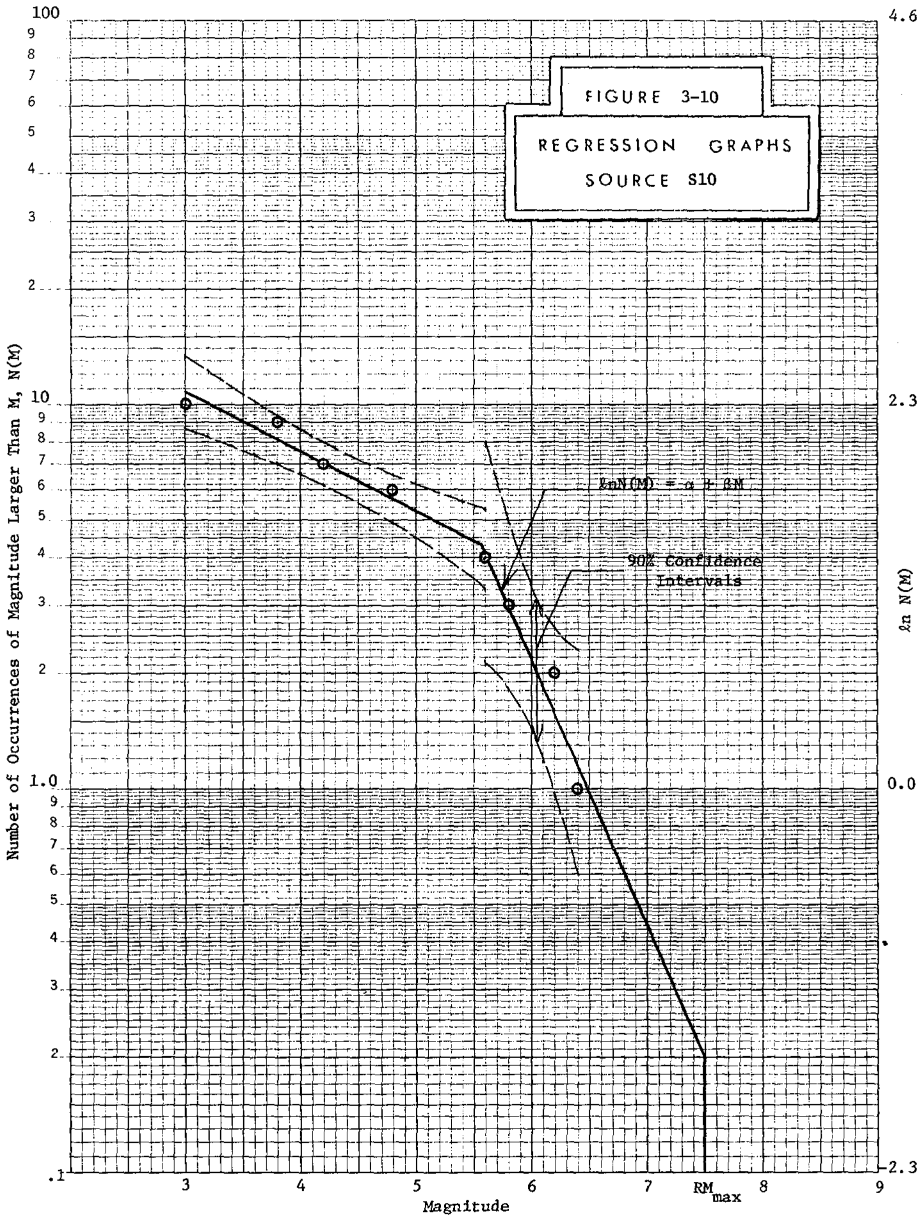


FIGURE 3-10

REGRESSION GRAPHS

SOURCE S10

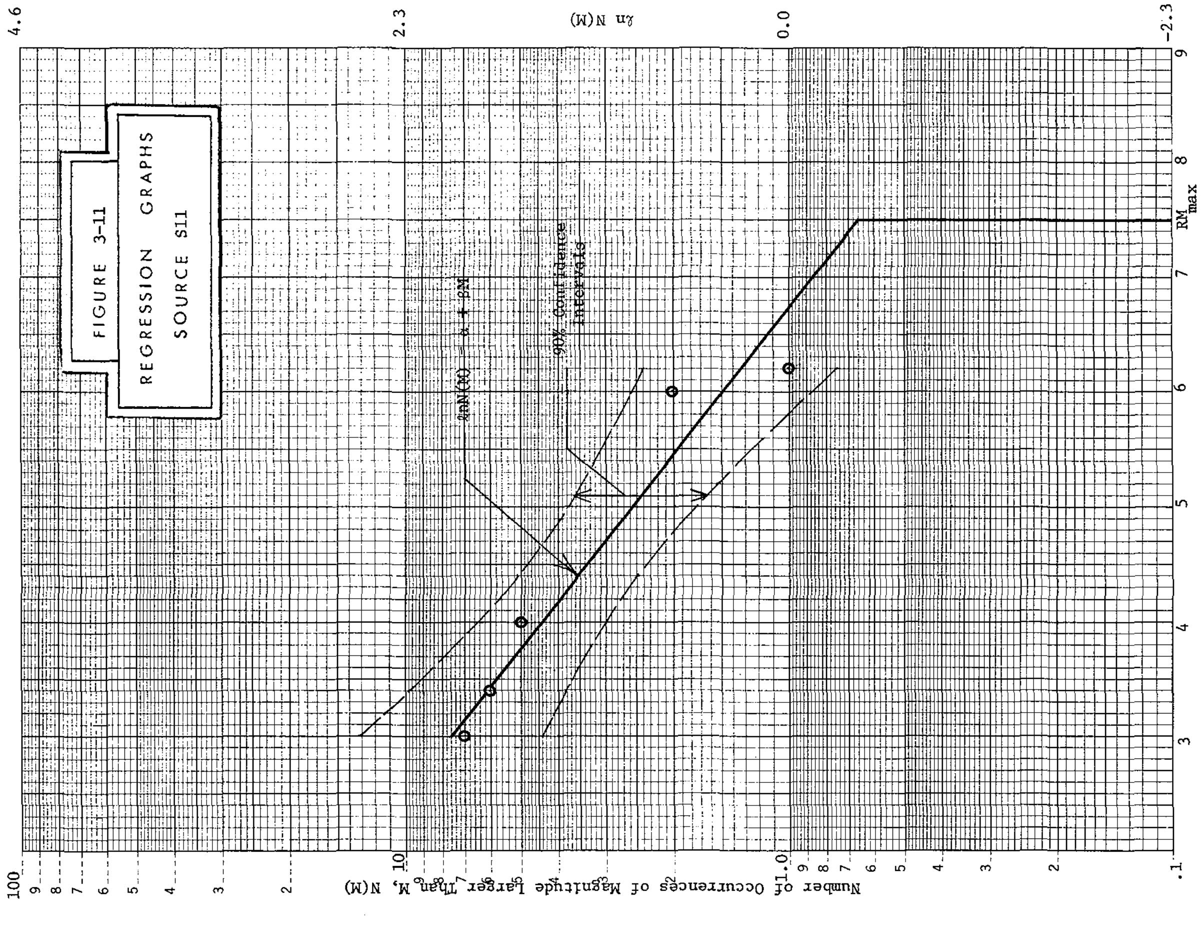


FIGURE 3-11

REGRESSION GRAPHS

SOURCE S11

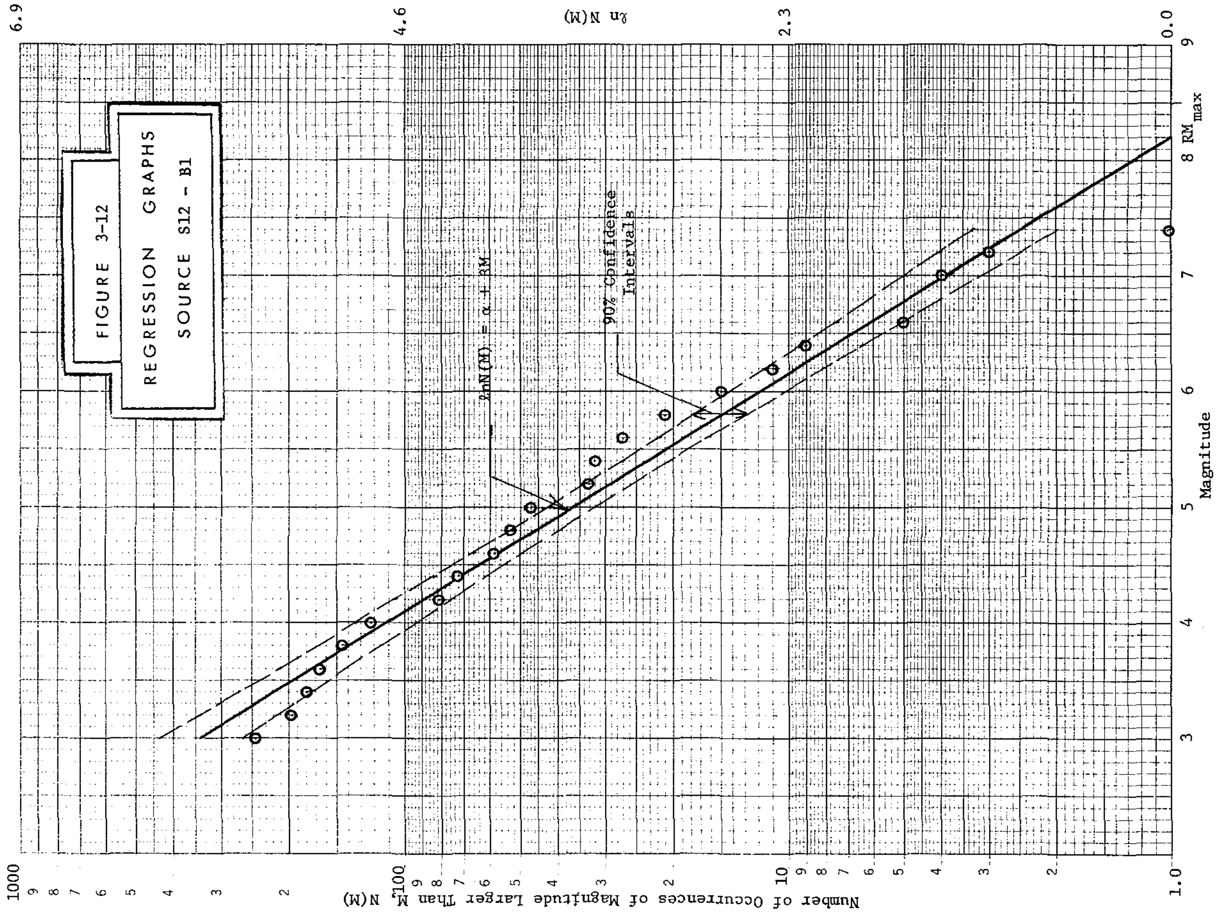


FIGURE 3-12

REGRESSION GRAPHS

SOURCE S12 - B1

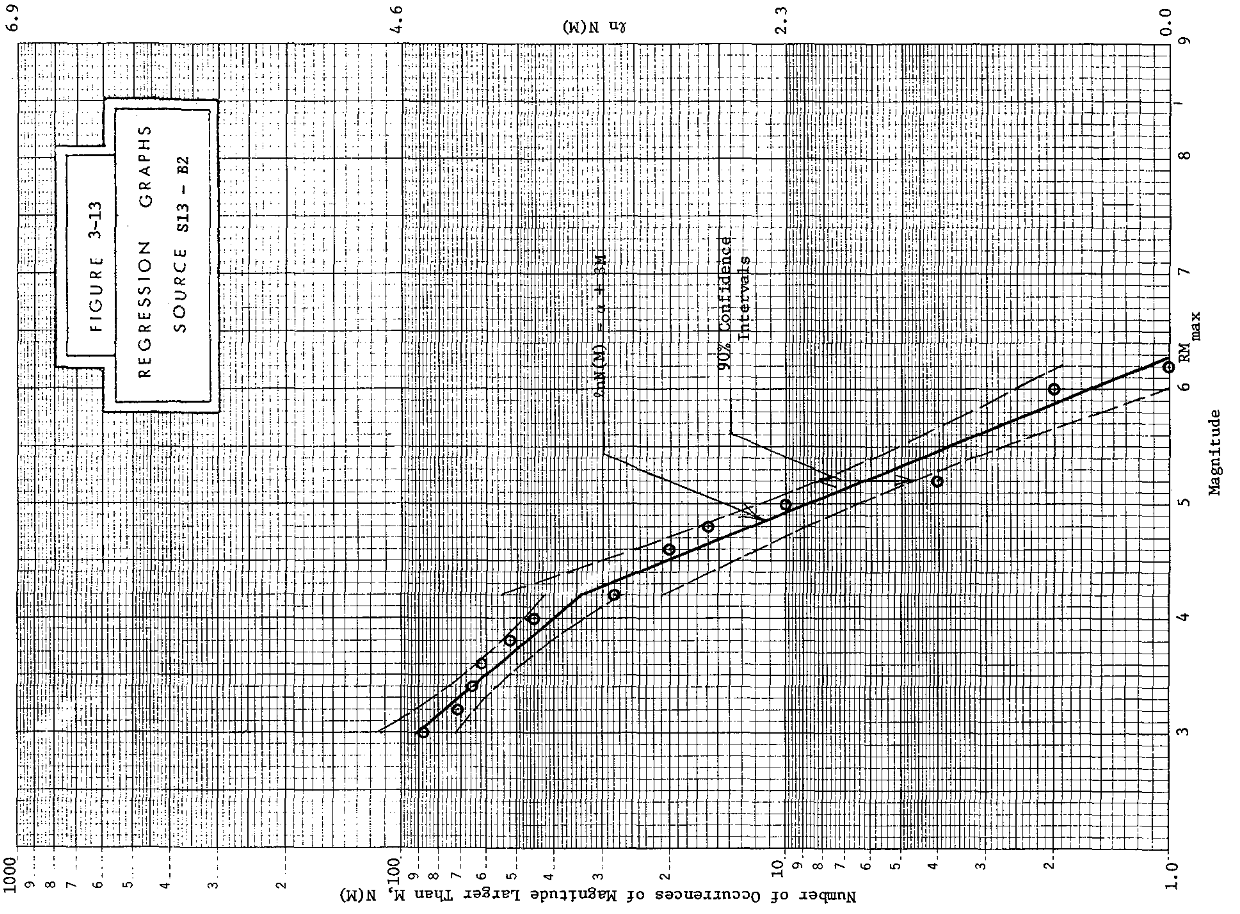


FIGURE 3-13
REGRESSION GRAPHS
SOURCE S13 - B2

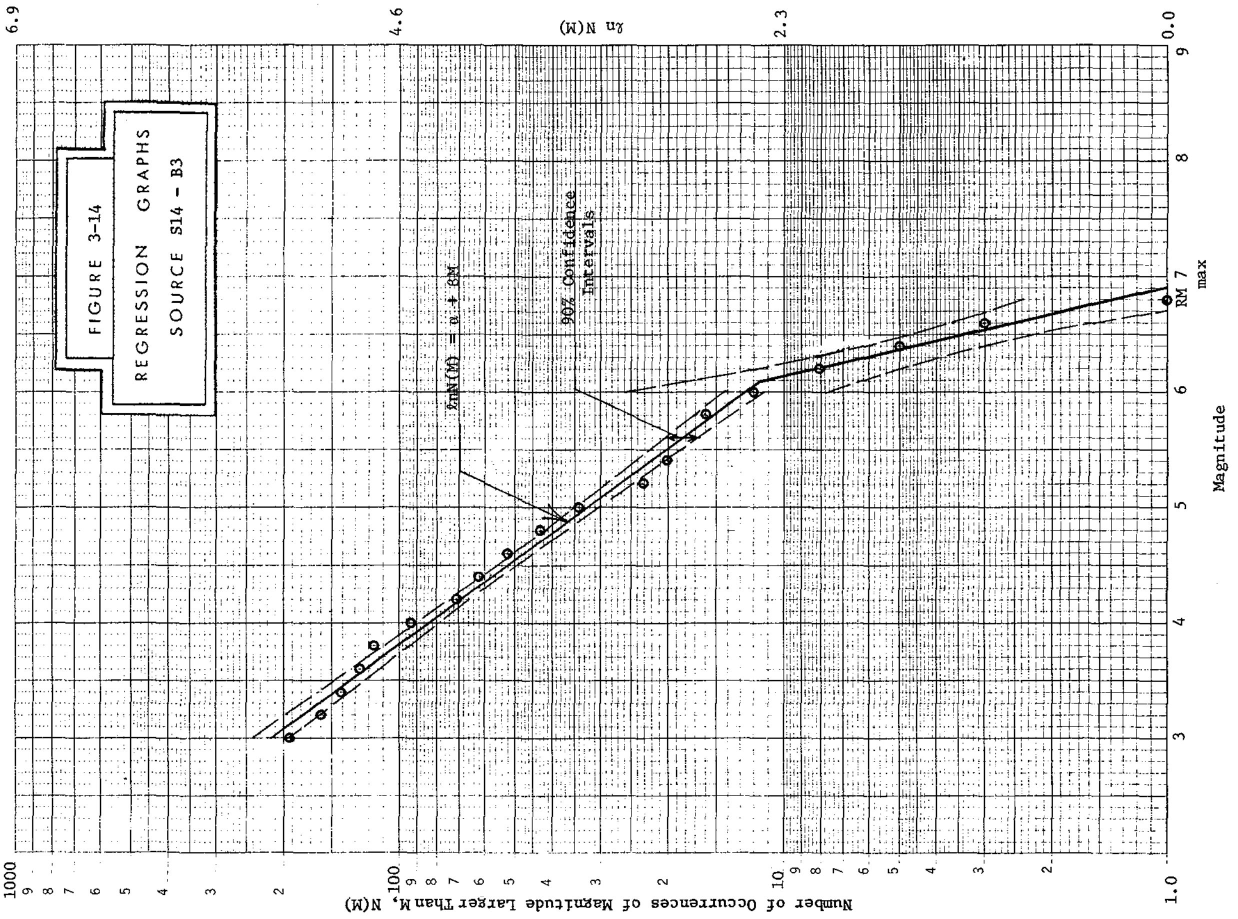


FIGURE 3-14
REGRESSION GRAPHS
SOURCE S14 - B3

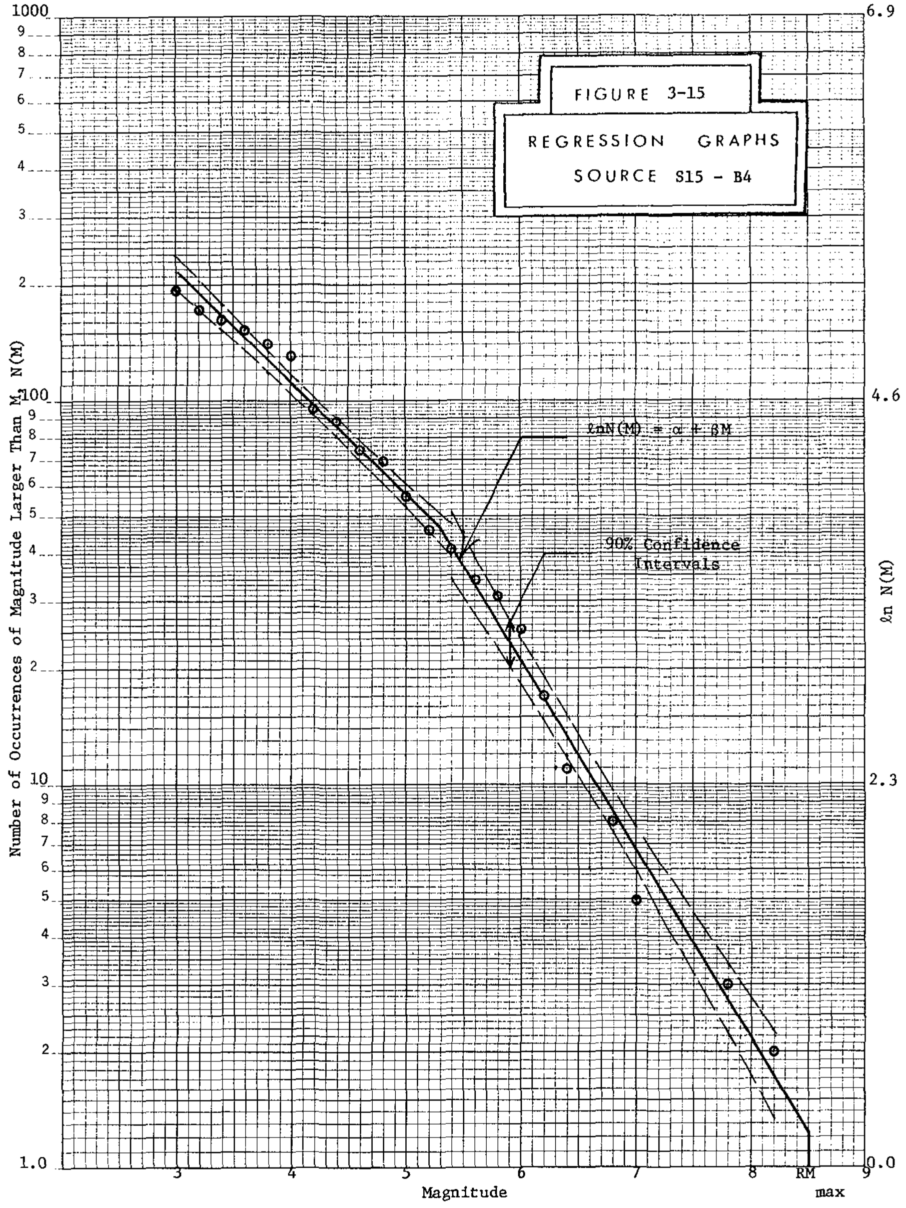


FIGURE 3-15

REGRESSION GRAPHS

SOURCE S15 - B4

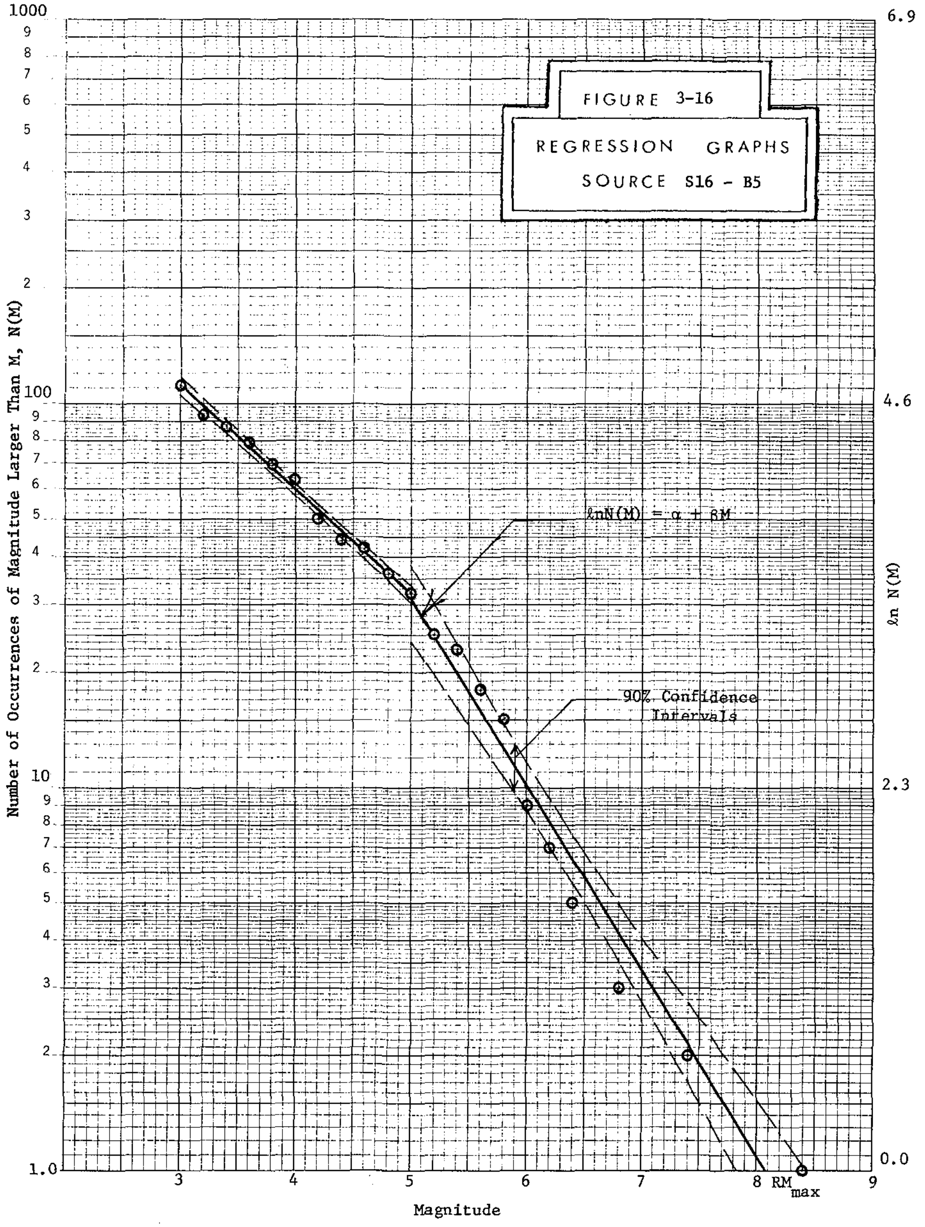


FIGURE 3-16

REGRESSION GRAPHS

SOURCE S16 - B5

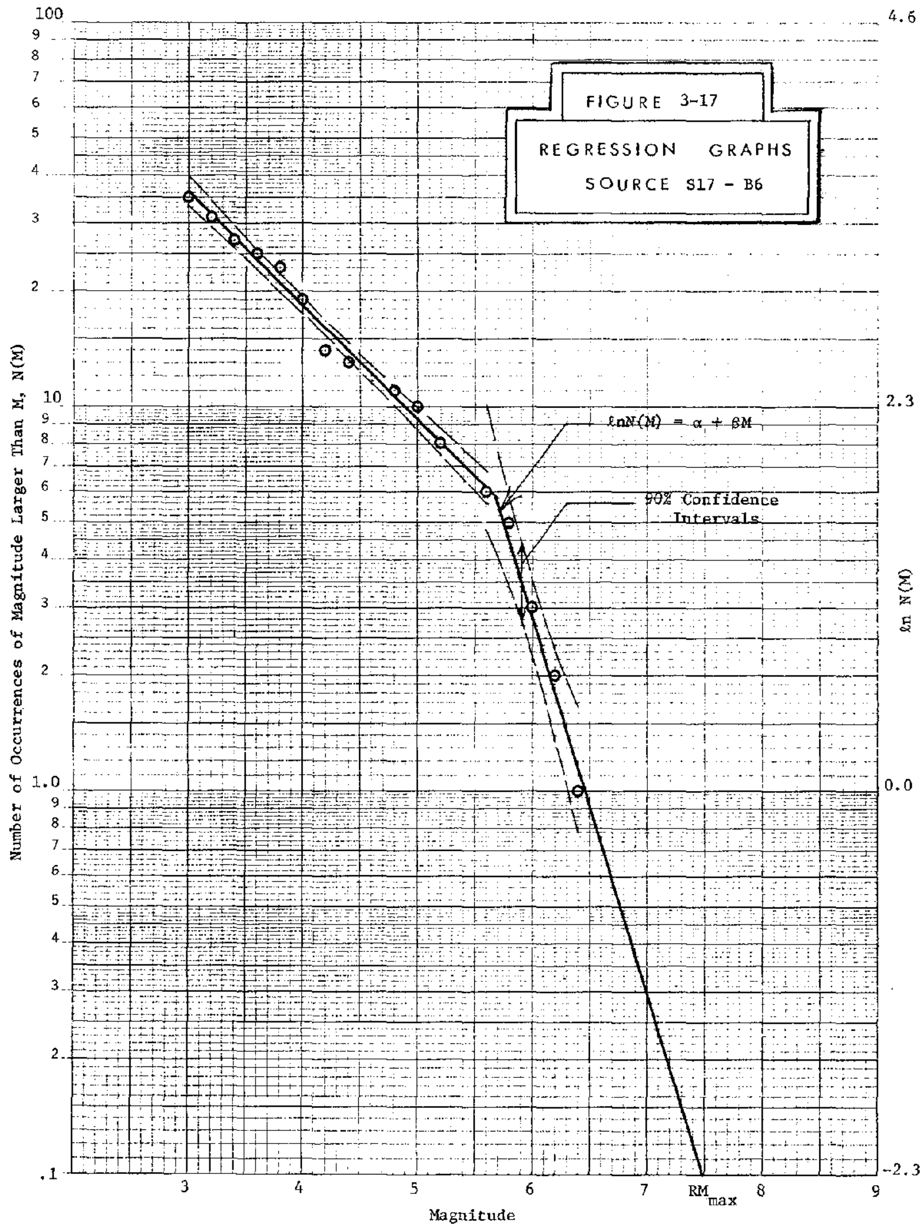


FIGURE 3-17

REGRESSION GRAPHS

SOURCE S17 - B6

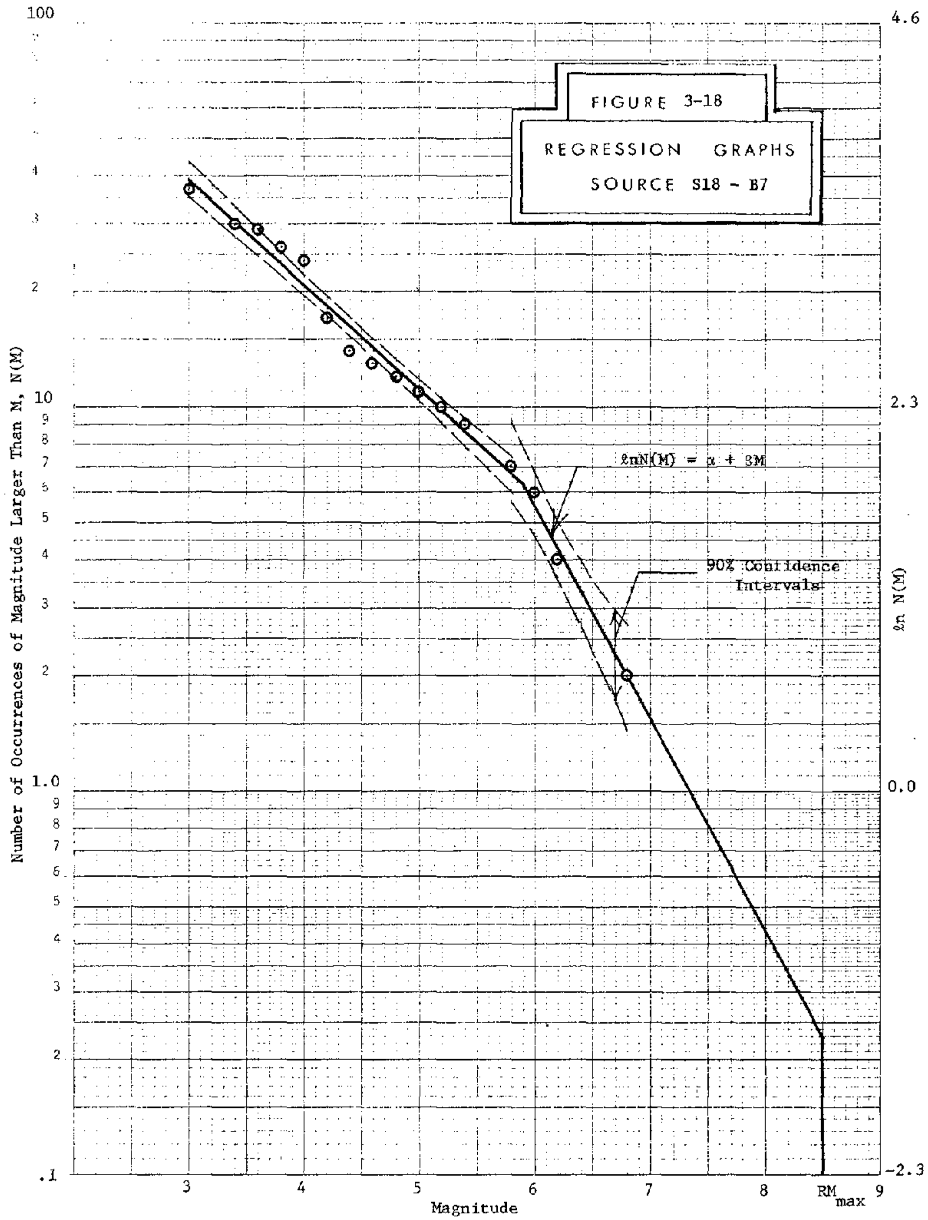


FIGURE 3-18

REGRESSION GRAPHS

SOURCE S18 - B7

TABLE 3-3

Line Source Information

Source	α'_1	β_1	α'_2	β_2	RM_{max} (recorded)	RM_{max} (cutoff)	Length (degrees)	RMBK
S1	-0.0632	-0.7955			7.5	8.5	4.84	
S2	-0.4323	-0.7961			6.0	8.0	3.52	
S3	-0.2486	-0.7211			6.8	8.0	2.72	
S4	-0.0023	-0.5579	10.4009	-2.1618	7.3	8.0	2.68	6.49
S5	2.1556	-1.3430			5.0	6.0	1.84	
S6	-0.4873	-0.6460			5.7	6.5	0.79	
S7	-0.0187	-0.6363			6.5	7.0	0.73	
S8	1.2284	-0.5930			6.1	7.4	0.30	
S9	-0.8131	-0.4753	1.0776	-0.8249	7.5	8.0	1.87	5.41
S10	-1.7146	-0.3591	5.1519	-1.5889	6.5	7.5	2.36	5.58
S11	-0.7026	-0.5397			6.3	7.5	1.12	
S12 - B1	2.9900	-1.1107			7.4	8.5	6.34	
S13 - B2	0.6477	-0.8098	4.3405	-1.6915	6.3	8.5	7.15	4.19
S14 - B3	1.8929	-0.9447	14.1711	-2.9741	6.8	8.5	7.39	6.05
S15 - B4	1.0108	-0.6659	3.4927	-1.1340	8.3	8.6	7.72	5.30
S16 - B5	0.1986	-0.6222	2.5188	-1.0979	8.4	8.6	7.83	4.88
S17 - B6	-0.7732	-0.6795	8.1302	-2.2485	6.5	8.5	8.02	5.67
S18 - B7	-0.8487	-0.6290	3.0325	-1.2867	6.9	8.5	8.02	5.90

A = Area of the area source

T = Time for which the data was obtained

N'(M) = Normalized mean number of events above magnitude M for unit-time (1 year) and unit-area or unit length.

Then

$$\ln N'(M) = \alpha' + \beta M \qquad 3\text{-}4$$

where $\alpha' = \alpha - \ln(AT)$ for area source

$= \alpha - \ln(LT)$ for line source.

Table 3-3 shows values of α', β and the upper cutoff magnitude as described previously. The table gives the values of α' and β normalized with respect to degrees of latitude and longitude and develop the forecasting model. RMBK is the Richter Magnitude where the slope of the recurrence lines change.

III-4 Confidence Levels

In addition to the α' and β parameters, the 90% confidence intervals are computed for all regression lines. These intervals are measures of the accuracy of the regression fit to the data. The 90% confidence intervals indicate that there is 0.90 probability that the true value of ln N(M) lines within these bounds (see Benjamin and Cornell, 1970, for further detail). For the cases of double regression lines, two separate confidence intervals are obtained for each segment. The discontinuity at the intersection of the two regression lines is to be expected since the least-squares fit for each segment is performed using its corresponding set of data independent of each other. The confidence lines for all the sources appear close to the regression line showing high confidence in the recurrence relationships. The confidence bounds are particularly good for sources S12 - B1 to S18 - B7, and are worse for S10 and S11. In general the intervals are narrow whenever there are many data points.

TABLE 3-4

Statistics of Regression Lines

Source	σ_1	ρ_1	V_1	σ_2	ρ_2	V_2
S1	0.245	0.955	.109			
S2	0.253	0.930	.150			
S3	0.221	0.949	.120			
S4	0.235	0.887	.084	0.159	0.970	.177
S5	0.276	0.927	.148			
S6	0.141	0.963	.147			
S7	0.163	0.956	.145			
S8	0.153	0.960	.087			
S9	0.111	0.912	.048	0.140	0.972	.135
S10	0.089	0.955	.046	0.193	0.932	.242
S11	0.254	0.930	.210			
S12 - B1	0.292	0.965	.085			
S13 - B2	0.128	0.900	.032	0.287	0.957	.149
S14 - B3	0.100	0.988	.025	0.244	0.952	.168
S15 - B4	0.081	0.978	.018	0.166	0.979	.067
S16 - B5	0.041	0.991	.010	0.213	0.968	.102
S17 - B6	0.073	0.985	.026	0.154	0.966	.148
S18 - B7	0.086	0.976	.031	0.078	0.987	.053

The constant standard deviation $\pm\sigma$ and the coefficient of variation V of ln N(M), which are indicators of the variability of the estimated regression line, are also determined for each source. The values of $\pm\sigma$ and V are given in Table 3-4. Most of the sources have low coefficients of variation V. It should be noted that in the model used for the probabilistic acceleration computations (Section III-3) a maximum of four sources have an affect on any given point in the worst cases. For such points the largest coefficient of variation due to the input data is found to be 14.5% assuming the contribution from all four sources are independent and the following relationship is true:

$$V_y^2 = V_{x1}^2 + V_{x2}^2 + V_{x3}^2 + \ldots + V_{xn}^2 \qquad 3\text{-}5$$

Most points will have a value for V much lower than 14.5%.

The correlation coefficients, ρ, shown in Table 3-4 express the degree of linear dependence of ln N(M) to M. For almost all sources ρ is greater than 0.9, a value of 1.0 indicating perfect linear correlation, thus denoting relatively high correlation between the variables.

III-5 Conclusion

Some of the limitations of the data were already discussed throughout the chapter. The variability of the regression equation was determined for each source and an upper bound uncertainty in the final probabilistic loads due to them were also obtained. Other sources of error in the modeling, such as fault locations, focal depths, and cutoff magnitudes, will be discussed through subsequent chapters.

It should be emphasized that as additional data becomes available to give more reliable information on epicentral locations, the methodology presented in this research project will be able to modify the results accordingly.

CHAPTER IV

PROBABILISTIC SEISMIC LOADING

Scope

In this chapter, the Poisson model used to analyse the available data is discussed briefly. The available data presented in Chapter III is used to obtain iso-acceleration maps of Guatemala. In addition, the cumulative probability distributions on peak ground acceleration for eight cities in Guatemala are also presented.

....

IV-1 Introduction

In Chapter III, the data base was discussed and the limitations of the available information and the approximations made in using the seismic data for Guatemala were reviewed. The recurrence relationships associated with all the seismic sources for the region were also presented. These recurrence relationships give the mean number of events of magnitude greater than M due to a seismic source and a time period. The normalized recurrence relationships are obtained when the mean number of events above a specified magnitude M is normalized with respect to the time period of the historic data and the length of the source in the case of line sources or the area of the source in the cases of area sources.

To determine the seismic risk in Guatemala, it is necessary to forecast earthquake events in this region. The three statistical models for forecasting that have been used previously are:

(1) Poisson model

(2) Markov model

(3) Bayesian model

In the present study, the Poisson model used by Shah et al. (1975) is adapted because of its simplicity, its widespread use in literature, and because the results it gives are very similar to results arising from more complex models such as the Markov Chain model. The development of the Poisson model is presented in Appendix A for completeness and further reference. In addition the Bayesian model of Mortgat (1976) is also used to develop seismic hazard maps for Guatemala for peak ground acceleration as well as for time duration of an earthquake. A review of the Bayesian model and the resulting hazard maps from its application to Guatemala are discussed in Appendix B.

IV-2 Iso-Acceleration Maps for Guatemala

Considering the Poisson model, the seismic sources and their corresponding frequency relationships were already discussed in the previous chapter. The maximum Richter magnitude was assigned to each source by considering the largest earthquake event associated with each source, the length of the source and the fault system to which it may belong. The values of the largest Richter magnitude recorded (RM_{max} recorded) and the cutoff Richter magnitude (RM_{max} cutoff) for each source is listed in Table 3-3. The attenuation relationship (see Equation A-9) used in the modeling is Esteva's (1973) equation given below:

$$a = \frac{5000 \exp (0.8M)}{(R_h + 40)^2} \qquad 4\text{-}1$$

where a = Peak Ground Acceleration in cm/sec^2

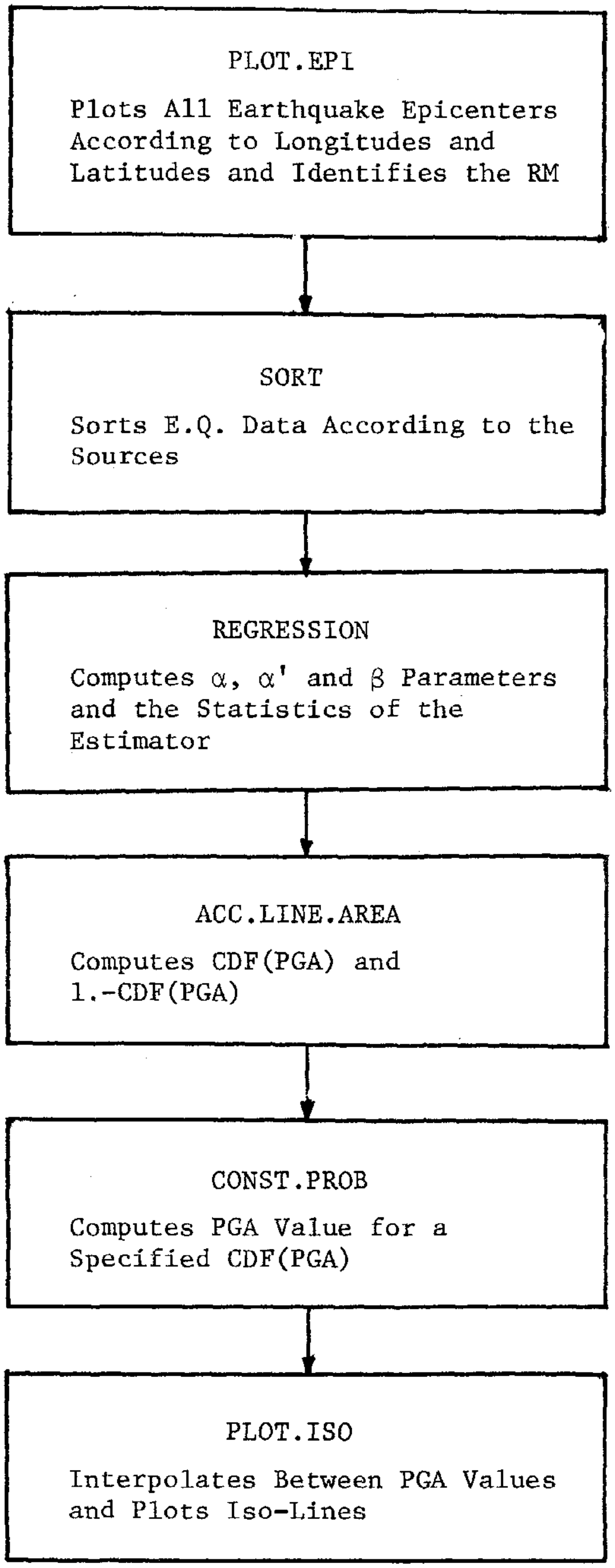
M = Richter magnitude

R_h = Hypocentral distance in km.

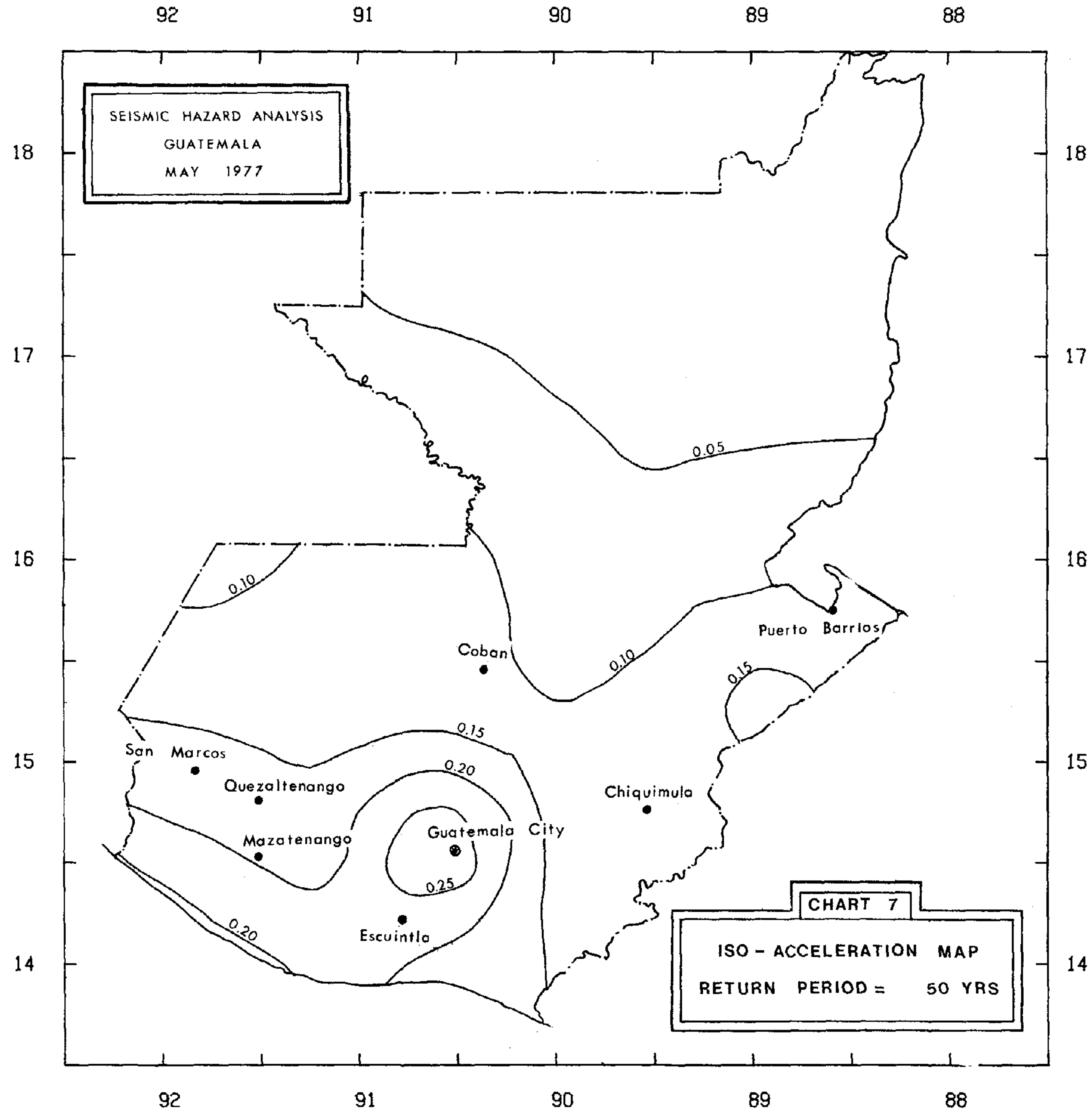
Since no strong motion records from major earthquake events or high amplitude accelerograph records are available for the Guatemalan region, it was not possible to adjust Esteva's equation or to obtain an attenuation relationship specific to Guatemala. The general feeling among Guatemalan geologists and seismologists is that the ground motion attenuates at a slower rate than in California, for example, however the peak ground acceleration values corresponding to each Richter magnitude are presumed to be lower. It is hoped that with the better instrumentation and additional strong motion recording in the future, these hypotheses can be scientifically substantiated, and consequently can be used for developing a new attenuation relationship. Such changes, it should be noted, can be easily incorporated in the seismic hazard model.

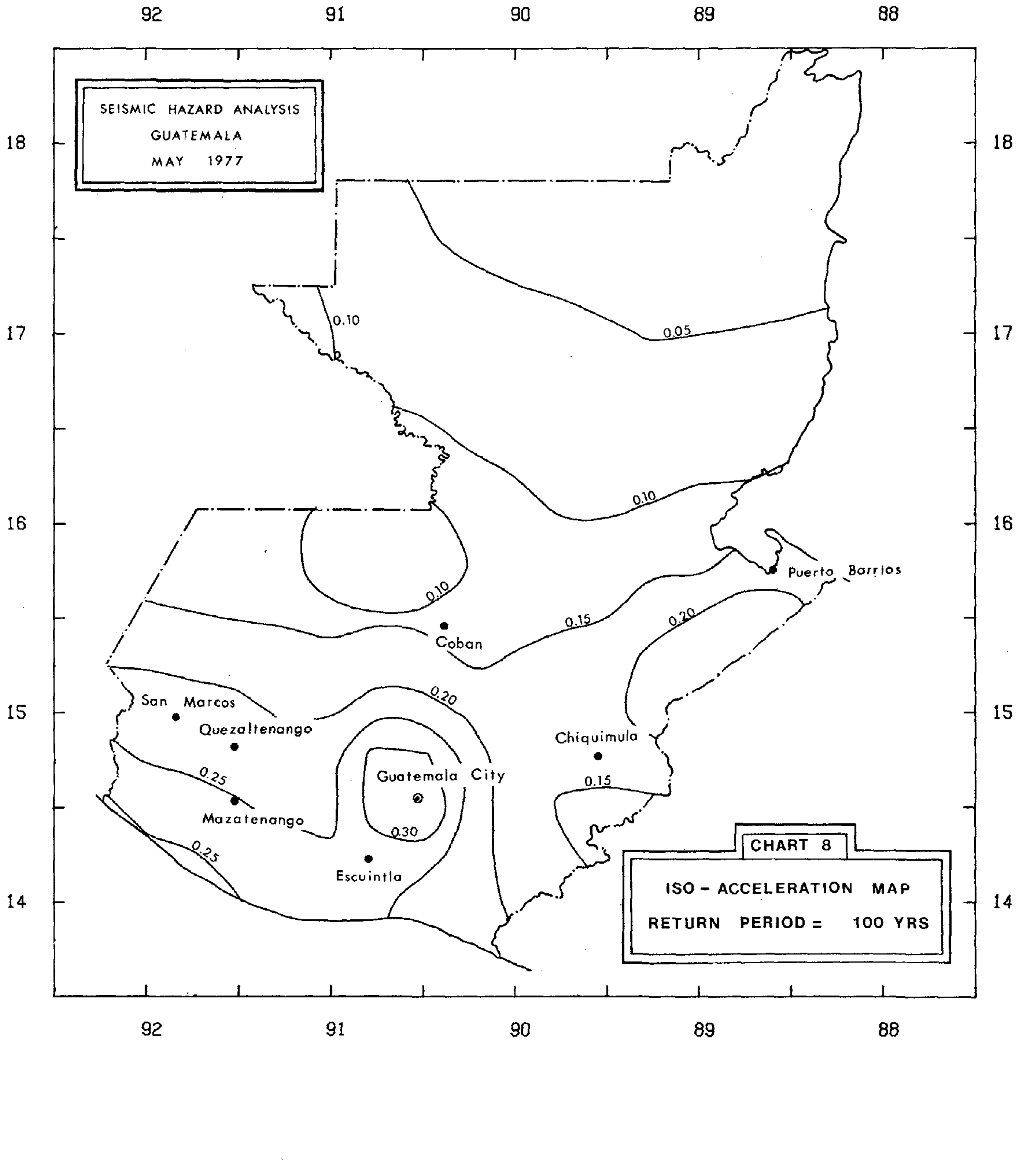
All of the above information along with the source location and focal depth, are put together in Equation A-34 (see Appendix A) to compute the cumulative probability distributions on peak ground acceleration. The entire country of Guatemala is divided into a grid of 1/4° longitude by 1/4° latitude spacings. The CDF of peak ground acceleration at each node on the grid is evaluated using the computer program ACC.LINE.AREA (see Appendix E). Then for a specified probability of exceedence, in other words for a specified hazard level, the peak ground acceleration values computed from the CDF's at each node are obtained using the computer procedure CONST.PROB. The iso-acceleration lines, which are lines of equal acceleration, are drawn by interpolation between nodal values of PGA. The program PLOT.ISO used in obtaining the hazard map contains both an interpolation routine and a graphical plotting routine. The flow chart below shows the major steps in the development of the map and the computer programs used at each step.

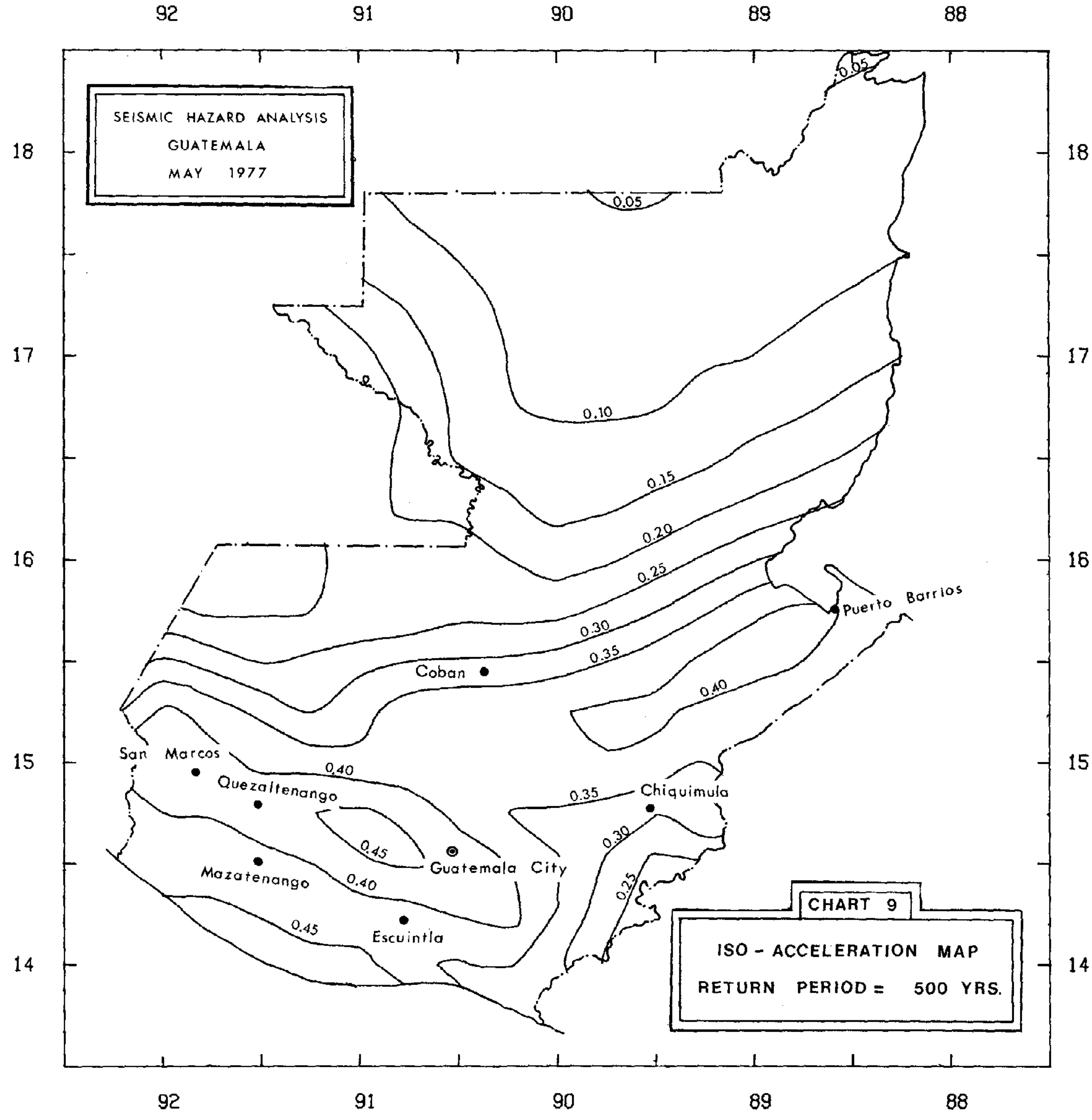
Iso-acceleration maps also referred to as seismic hazard maps are obtained for return period of events of 50, 100, 500, and 1000 years. Charts 7 to 10 show the iso-acceleration maps for these return periods.

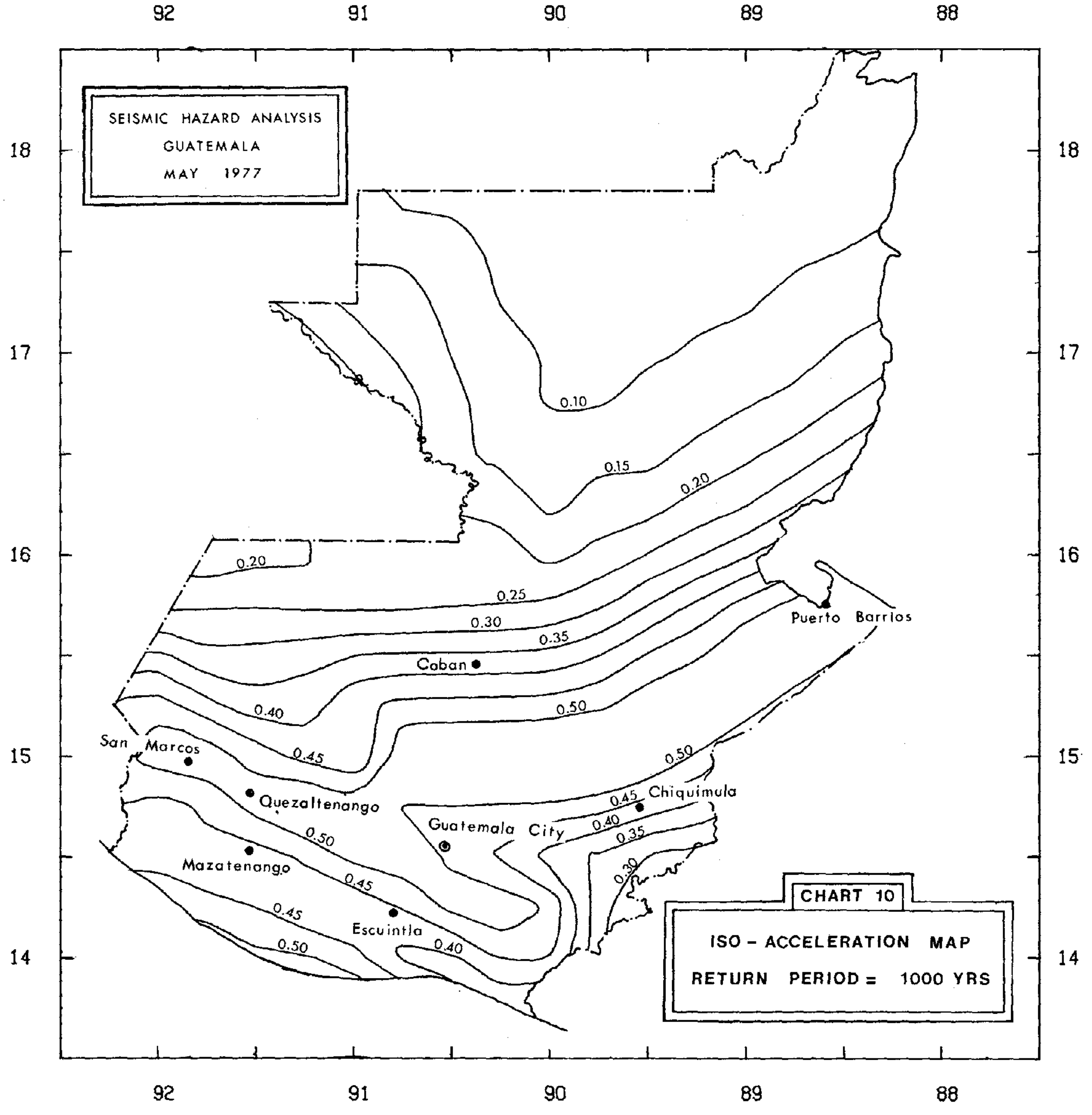


A listing of all programs is given in Appendix E.

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART 7
ISO - ACCELERATION MAP
RETURN PERIOD = 50 YRS
92
91
90
89
88
18
17
16
15
14
0.05
0.10
0.10
0.15
0.15
0.20
0.20
0.25
Coban
Puerto Barrios
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Chiquimula
Escuintla


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART 8
ISO - ACCELERATION MAP
RETURN PERIOD = 100 YRS
92
91
90
89
88
18
17
16
15
14
0.05
0.10
0.10
0.10
0.15
0.15
0.20
0.20
0.25
0.25
0.30
Puerto Barrios
Coban
San Marcos
Quezaltenango
Chiquimula
Guatemala City
Mazatenango
Escuintla


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART 9
ISO - ACCELERATION MAP
RETURN PERIOD = 500 YRS.
92
91
90
89
88
18
17
16
15
14
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
Coban
Puerto Barrios
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Escuintla
Chiquimula


92
91
90
89
88
18
17
16
15
14
SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
0.10
0.15
0.20
0.20
0.25
0.30
0.35
Puerto Barrios
Coban
0.40
0.50
0.45
San Marcos
0.50
Quezaltenango
0.45
Chiquimula
Guatemala City
0.40
0.35
0.50
Mazatenango
0.30
0.45
0.45
Escuintla
0.50
0.40
CHART 10
ISO - ACCELERATION MAP
RETURN PERIOD = 1000 YRS

The concept of return period and economic life in conjunction with exceedence probabilities will be discussed in Chapter V. Detailed methodology describing the use of these maps for structural design will be presented in the Part II report of the present study.

From these maps a low seismicity range is observed in the northern part of Guatemala. The high seismicity region in the south-southwestern part of Guatemala reaches a peak at the intersection of the Motagua fault, the Benioff zone and the Mixco fault. These high and low regions are in compliance with both the geologic as well as the seismologic data for the country.

In addition to the seismic hazard maps for the whole country, the following cities were studied in detail:

1. Guatemala City
2. Quezaltenango
3. Mazatenango
4. Chiquimula
5. Puerto Barrios
6. Escuintla
7. San Marcos
8. Copan

Figures 4-1 through 4-8 show the cumulative distribution function of peak ground acceleration for each of the cities. The results are presented for 50 years of future exposure time. The seismicity of Guatemala City appears to be the highest and for Coban it is the lowest.

The implications of these probability values and the corresponding acceleration values will be discussed in Chapter V.

When the cumulative distribution plots for different cities are compared, one can see the relative seismicity in terms of peak ground acceleration for each city. In conclusion, it can be said that one method of representing seismic risk is by means of cumulative distribution function plots of Figures 4-1 through 4-8.

The engineering interpretation of these results will be presented in the Part II report of the present study. It should also be pointed out that the iso-acceleration maps and any zoning based on such maps only represent macro characteristics. The macrozoning of the country should be modified with site-specific micro characteristics to microzone a given region. In that case, the local geotechnical and geological features (such as those discussed in Chapter II) should be incorporated together with the macro characteristics presented in this chapter.

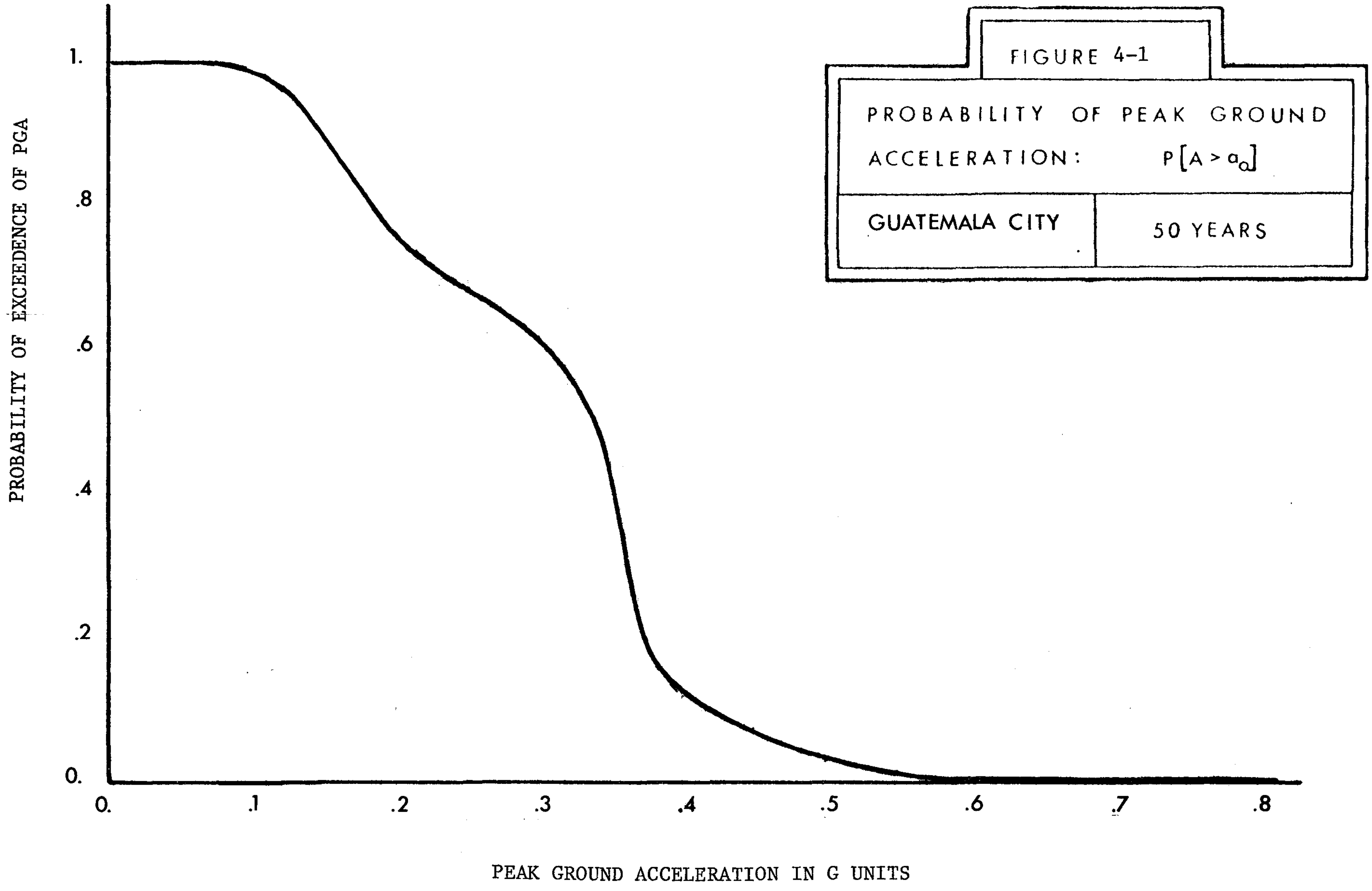


FIGURE 4-1

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_a]$

GUATEMALA CITY — 50 YEARS

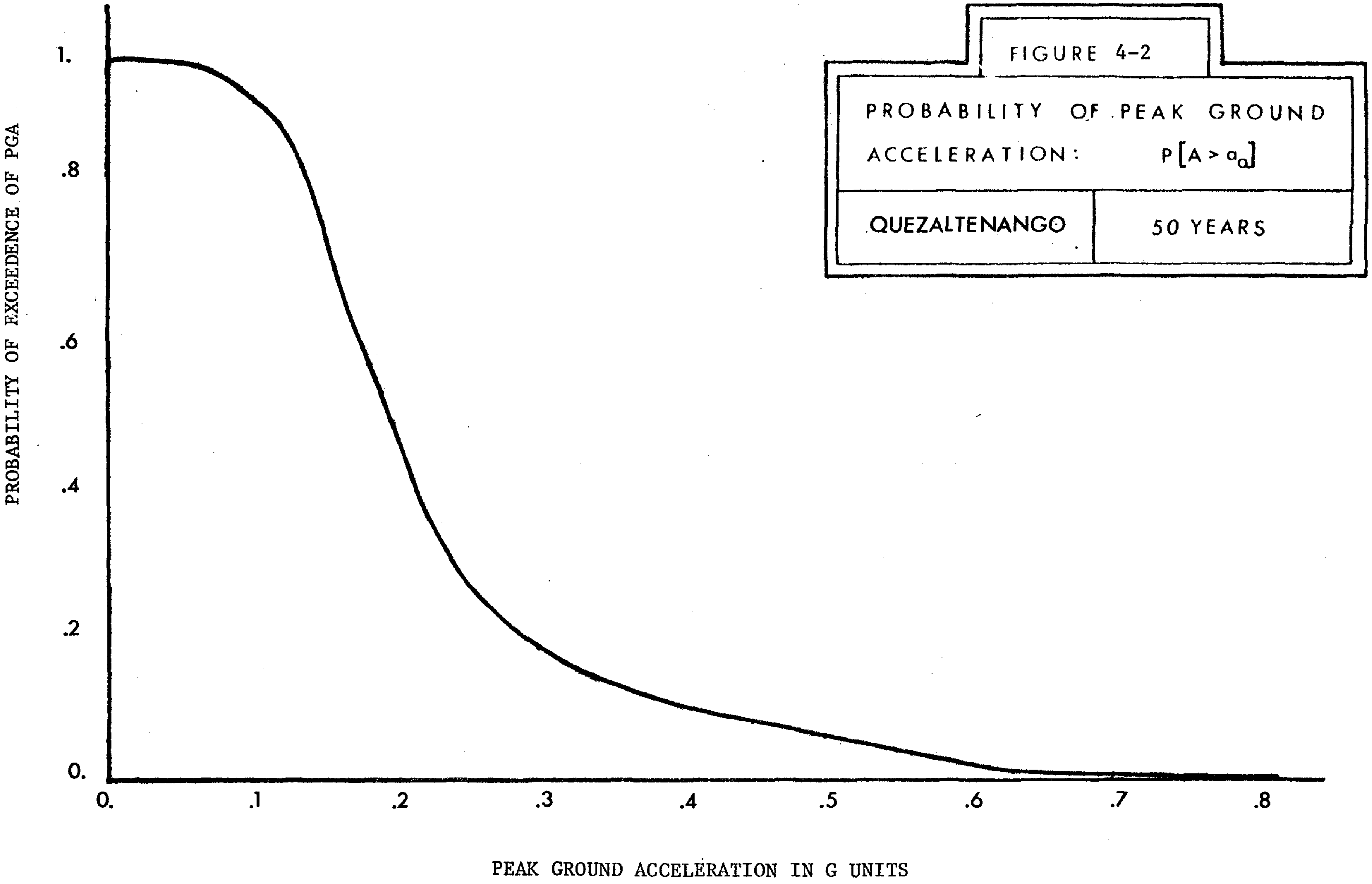


FIGURE 4-2

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_a]$

QUEZALTENANGO | 50 YEARS

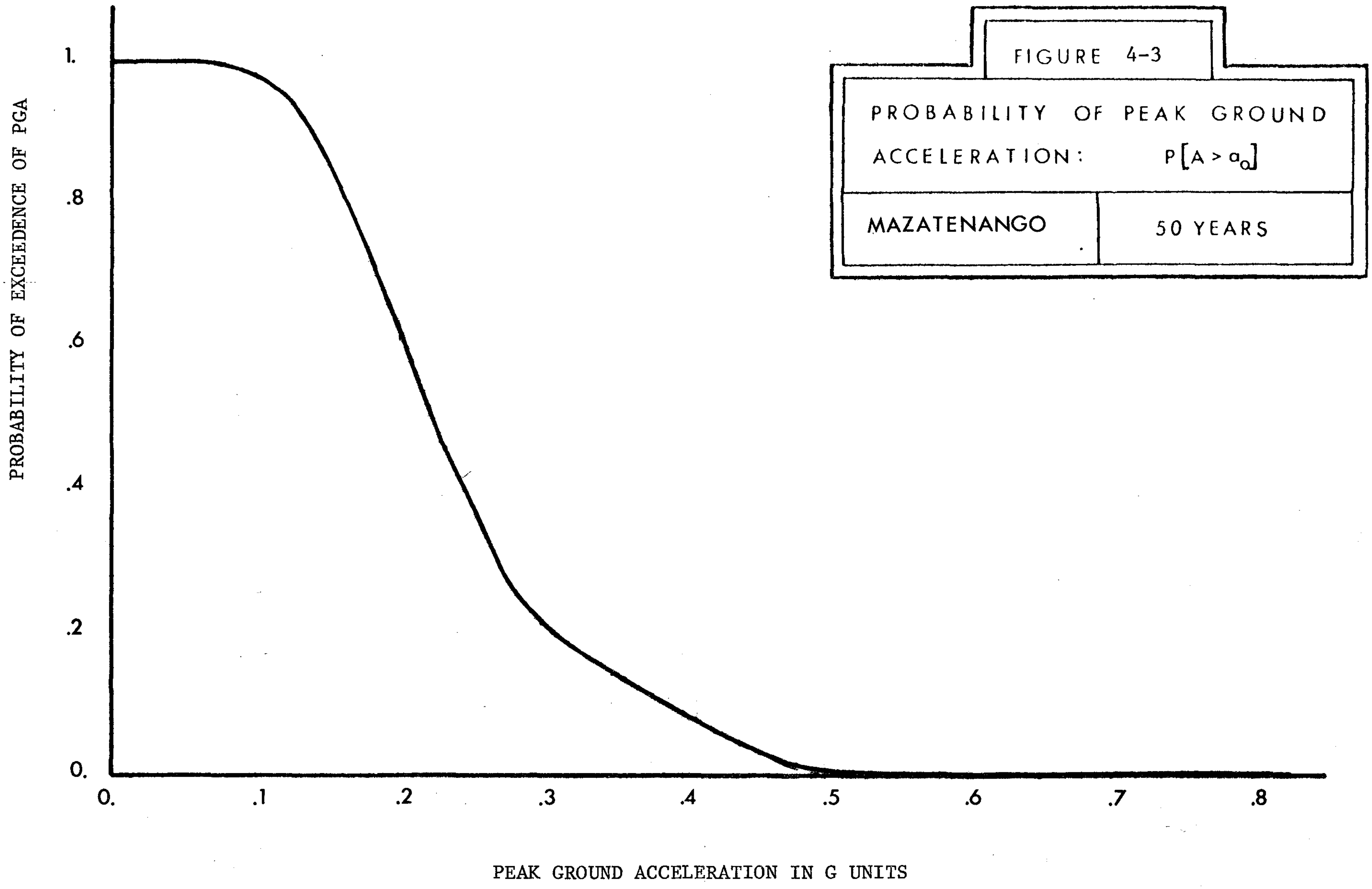


FIGURE 4-3

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_o]$

MAZATENANGO | 50 YEARS

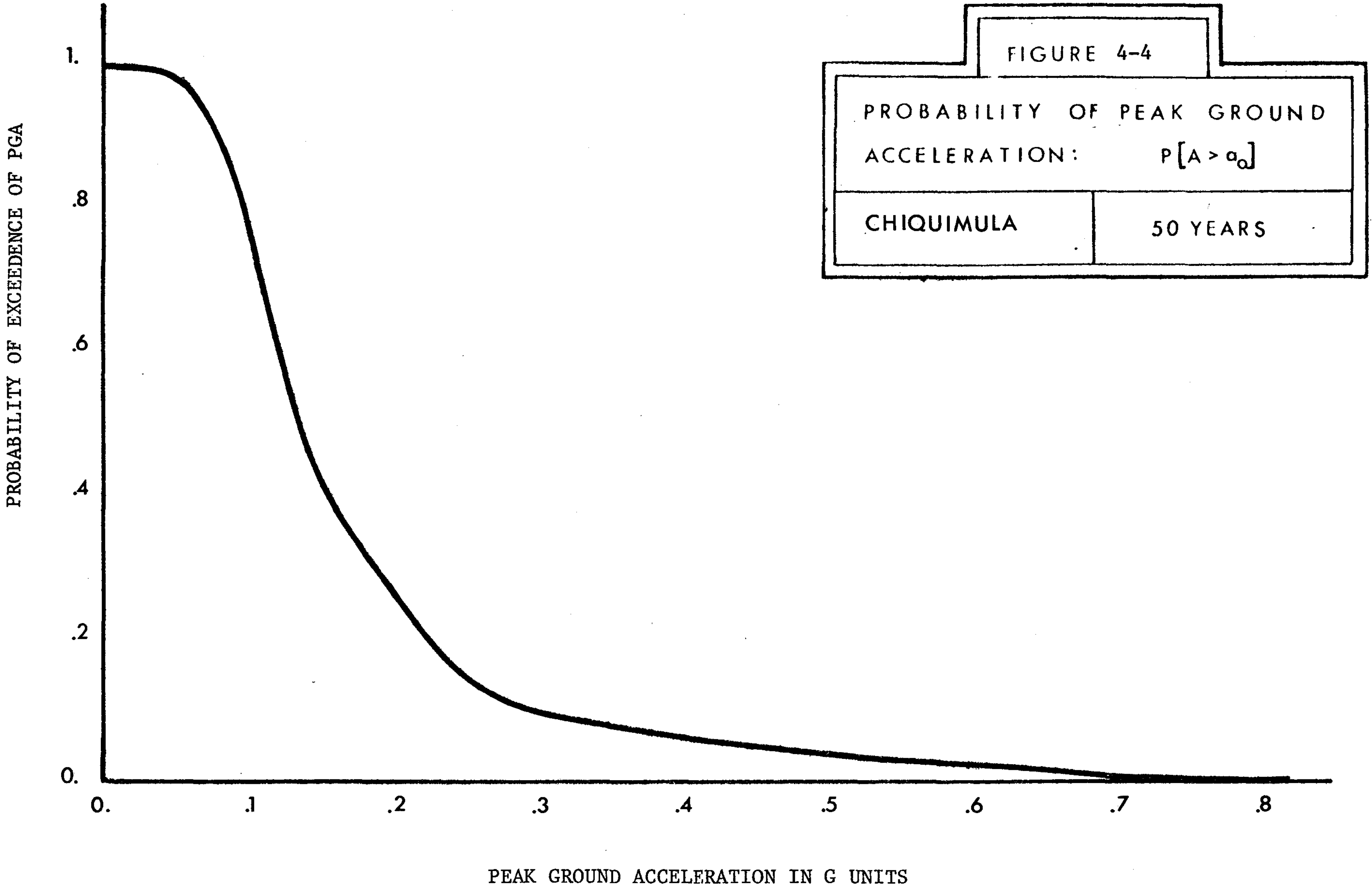


FIGURE 4-4

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_o]$

CHIQUIMULA 50 YEARS

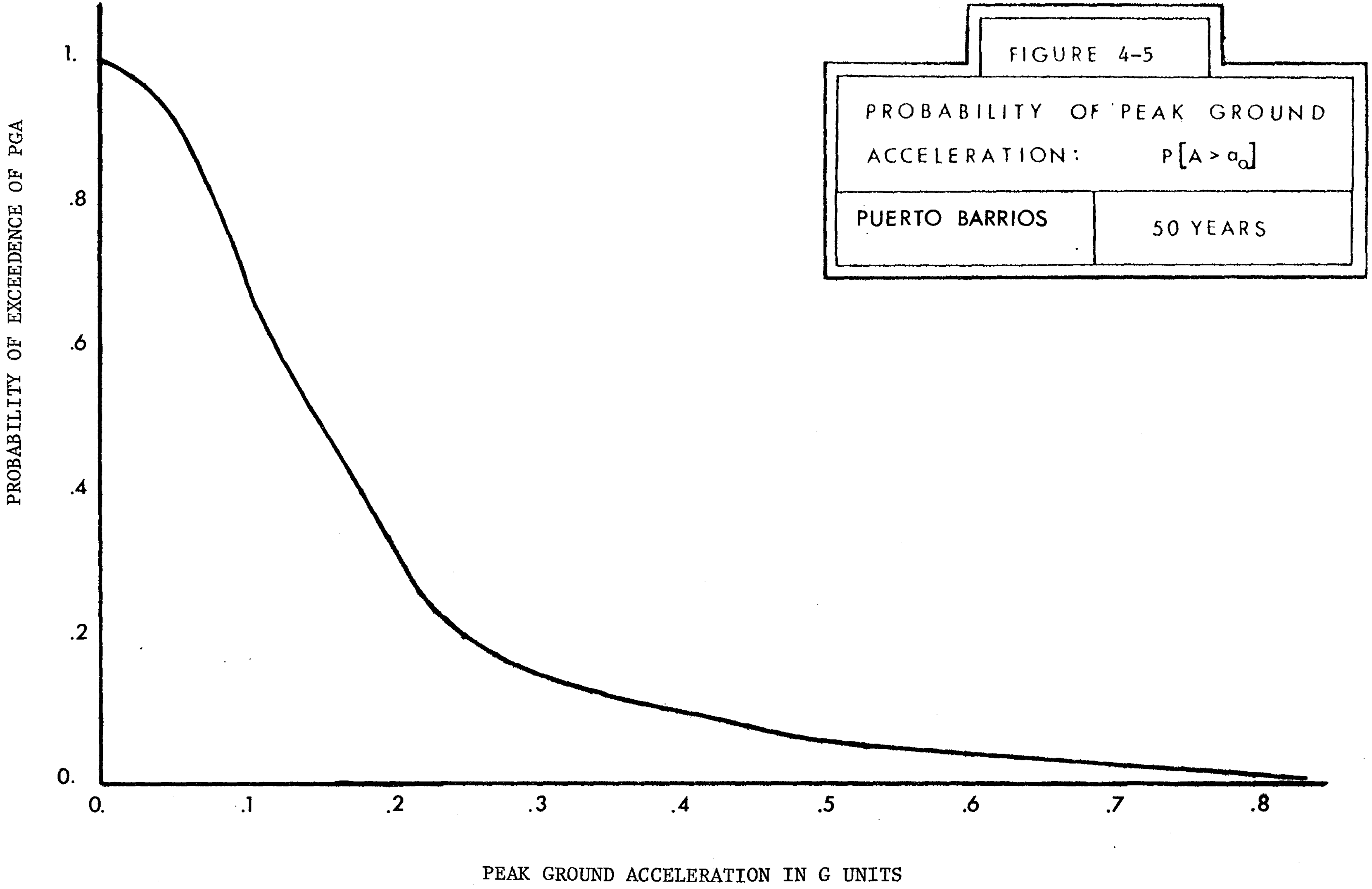


FIGURE 4-5

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_a]$

PUERTO BARRIOS 50 YEARS

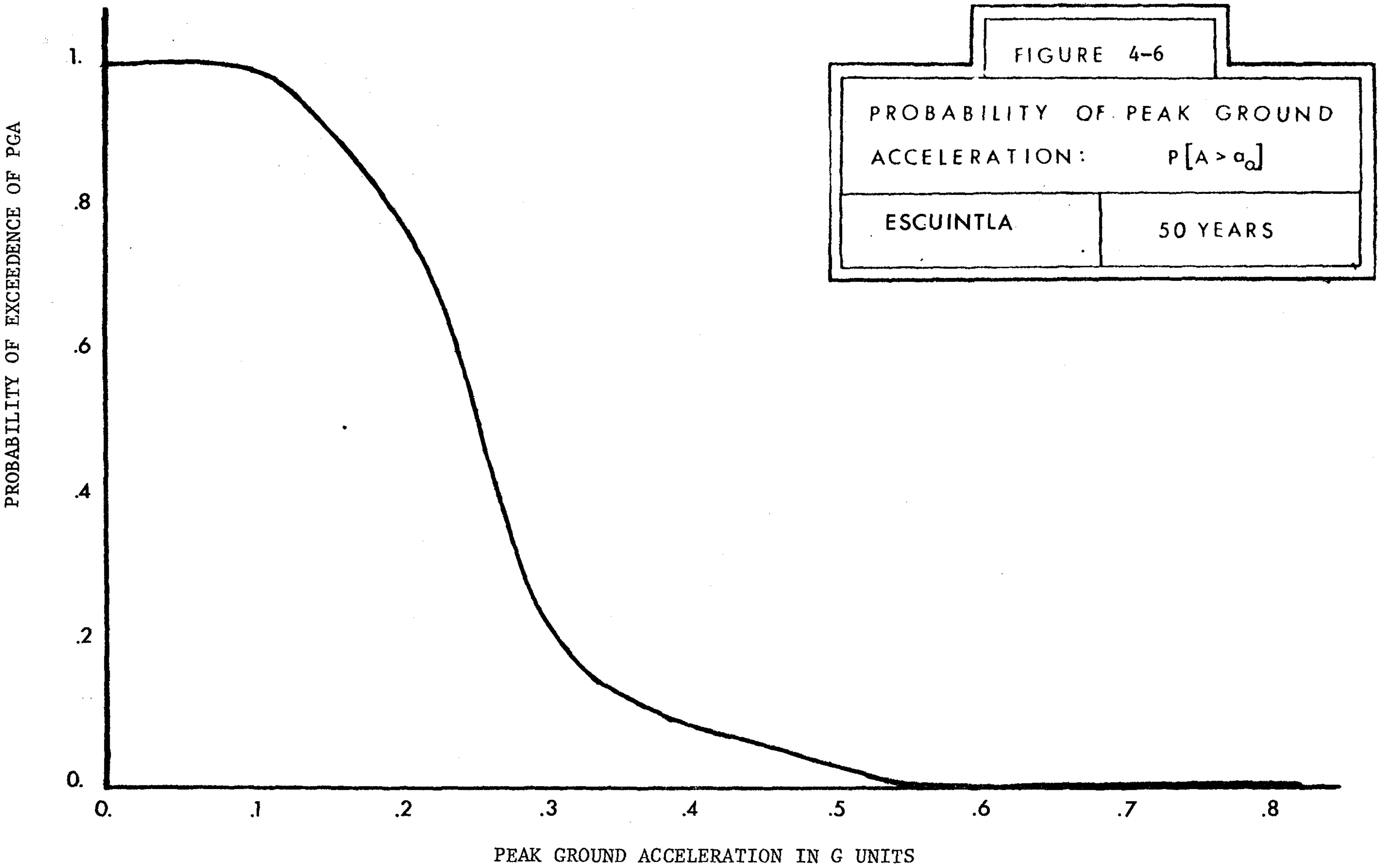


FIGURE 4-6

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_o]$

ESCUINTLA

50 YEARS

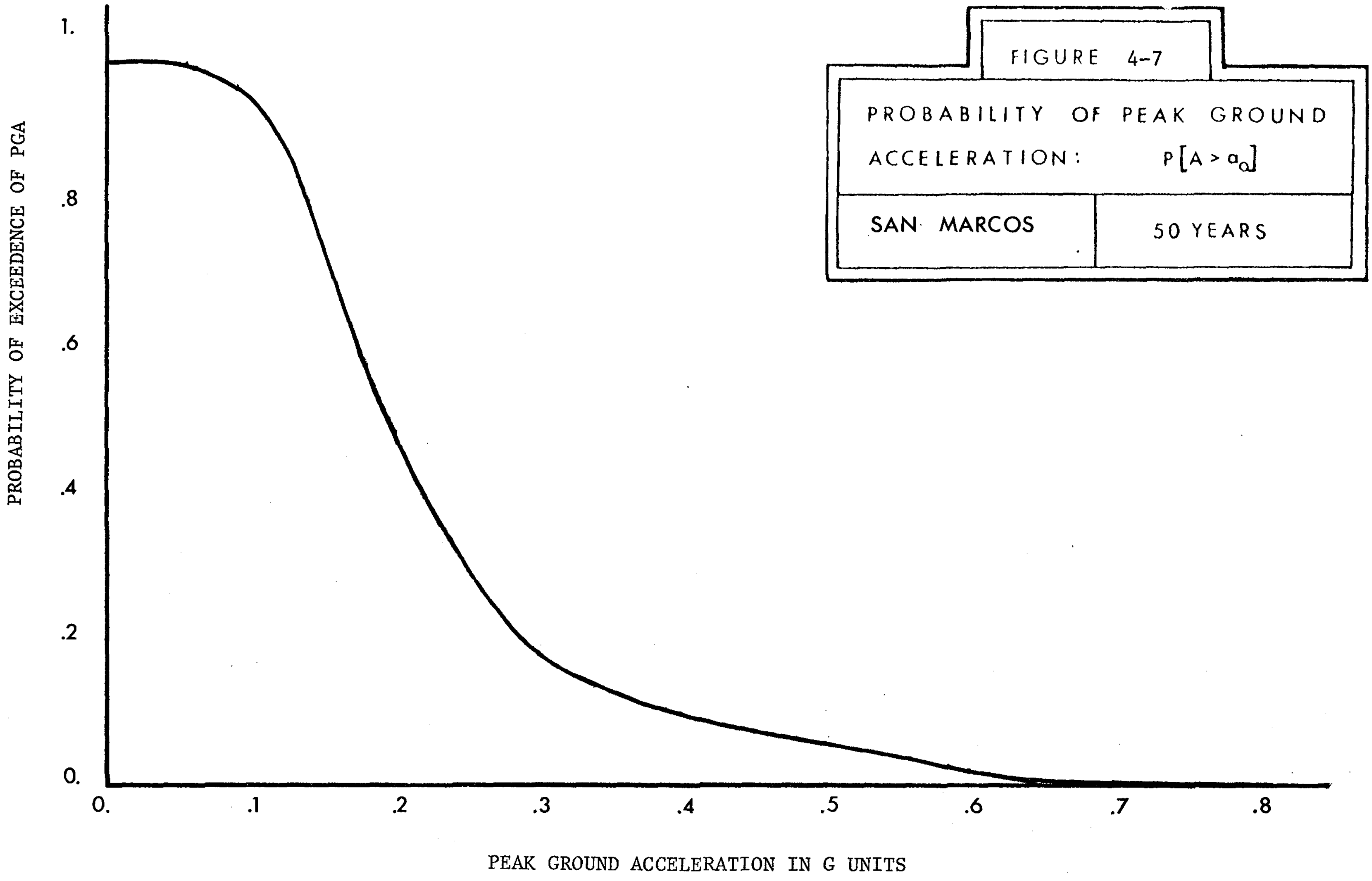


FIGURE 4-7

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_a]$

SAN MARCOS — 50 YEARS

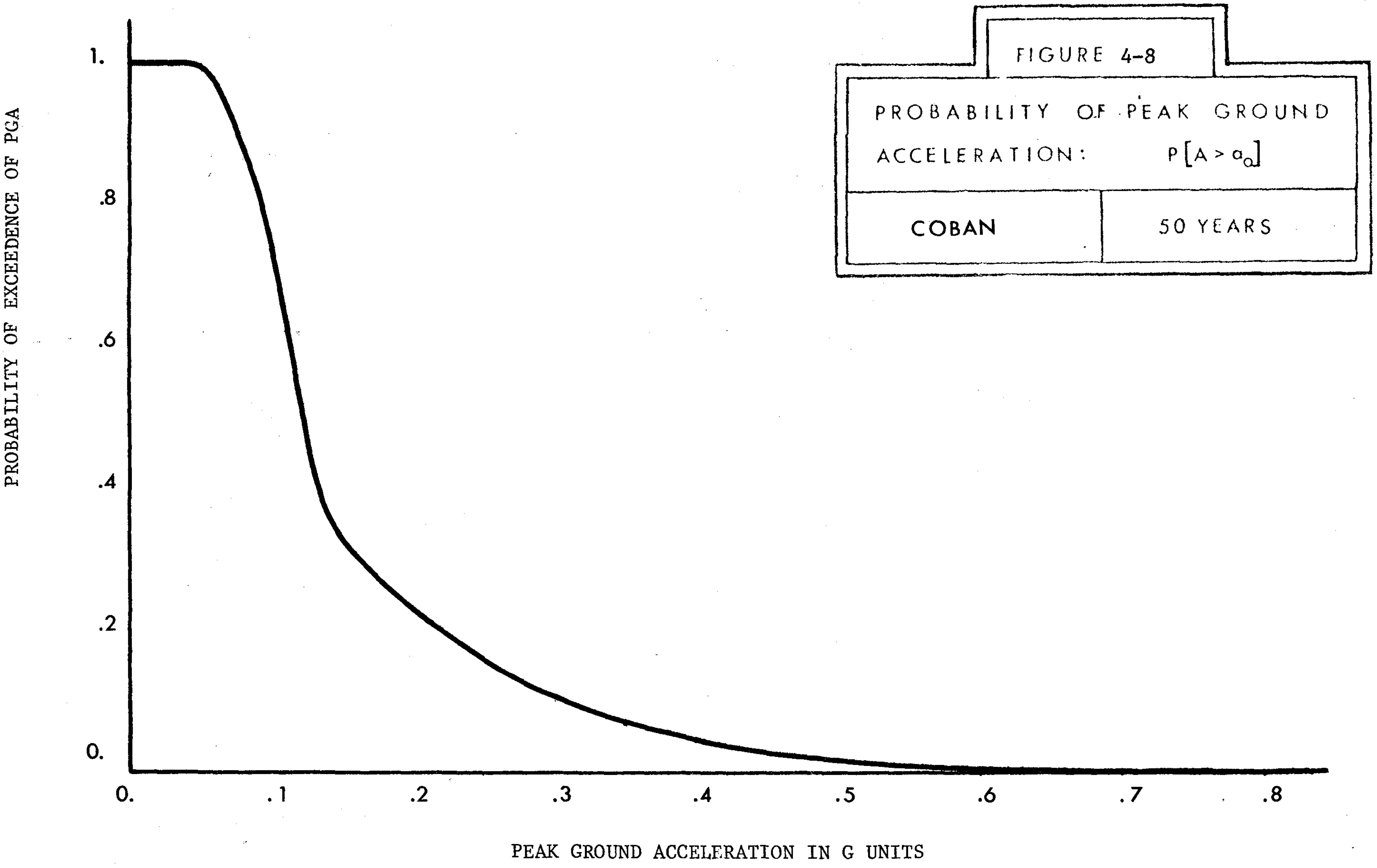


FIGURE 4-8

PROBABILITY OF PEAK GROUND ACCELERATION: $P[A > a_o]$

COBAN 50 YEARS

CHAPTER V

SEISMIC RISK ZONING

Scope

In this chapter, the concept of return period and economic life is discussed in detail. The iso-acceleration maps are used to develop acceleration zone graphs for seven cities in Guatemala.

....

V-1 Concept of Return Period and Acceleration Zone Graphs (AZG)

In deriving the probabilistic loading at a given site as a function of time, it is assumed that the forecasting process is Poisson. This process implies that the events are independent in time and space. Using this assumption and an appropriate attenuation relationship, the iso-acceleration maps for the country were developed. As mentioned in Chapter IV, the cumulative distribution function of the peak ground acceleration A, were obtained for eight cities. Consider the cumulative distribution function of peak ground acceleration in Guatemala City for an exposure time of 50 years. (See Figure 4-1.)

Then

$$P_{50} \ (A > 0.20g) = 0.76 \qquad 5\text{-}1$$

Equation 5-1 can be interpreted in the following way: "For Guatemala City, there is a 76% chance that during the next 50 years, the peak ground acceleration of 0.20g will be exceeded at least once."

Thus, there is a 24% chance that for Guatemala City, 0.20g peak ground acceleration will not be exceeded a single time.

Hence,

$$P \ (\text{Zero exceedence of } 0.20g \text{ in } 50 \text{ years}) = 0.24$$

From the Binomial Probability Law, it is known that for independent trials with probability of success p at each trial, the probability of r successes in n trials is given by

$$P_n(r) = \binom{n}{r} p^r (1-p)^{n-r} \qquad 5\text{-}2$$

where

$$r = 0, 1, \ldots n; \quad n = r, r+1, r+2, \ldots$$

and

$$\binom{n}{r} = \frac{n!}{r!\,(n-r)!}$$

Let each trial be a one-year duration for which the level of peak ground acceleration is under consideration. Define success as that event when the peak ground acceleration for a given trial (year) exceeds 0.2g. Thus, the probability of zero exceedence of level 0.2g in 50 years is the same as the probability of 0 successes in 50 trials. Hence, from Eq. 5-2:

$$P_{50}(0) = \binom{50}{0} p^0 (1-p)^{50}$$

$$P_{50}(0) = (1-p)^{50}$$

However,

$$P_{50}(0) = 0.24$$

$$(1-p)^{50} = 0.24$$

or

$$p = 0.028.$$

Thus, for Guatemala City, there is a 2.8% chance that in any given year, a peak ground acceleration of 0.20g will be exceeded.

However, the return period is defined as

$$\text{Return Period} = \text{RP} = \frac{1}{p} \qquad 5\text{-}3$$

Thus, the return period RP in Guatemala City for a peak ground acceleration of 0.20g is $\frac{1}{0.028} \approx 36$ years.

It should be pointed out that this return period of 36 years corresponding to 0.2g, obtained by using the cumulative distribution function (CDF) of PGA at Guatemala City for a 50 year exposure time does not change if we use the CDF with a different future exposure time period.

Thus, using the CDFs for all the cities in Guatemala considered in Chapter IV, a table can be developed for peak ground acceleration and return period. Table 5-1 is a general table giving this relationship for the cities considered. The following statements should be understood in using the concept of return period:

(1) A return period is the mean (or average) waiting time for an event of interest. Thus, the average (waiting) time between 2 events producing 0.20g in Guatemala City is approximately 36 years.

(2) The probability that an event corresponding to a return period RP will occur in any given year is given by $p = \frac{1}{\text{RP}}$. Thus, probability of exceeding 0.20g in Guatemala City in any given year is $\frac{1}{36} \approx .028$.

(3) The probability that not a single event of the RP type will occur in RP years is given by $\frac{1}{e}$ where $e = 2.718$, the Naperian base. Thus, probability that in 36 years, there will not be a single event producing a peak ground acceleration of 0.20g in Guatemala City is given by $\frac{1}{e} \approx 0.36$.

Hence, there is 64% chance that in RP years there will be at least one event of RP type. For Guatemala City, there is a 64% chance that in 36 years

TABLE 5-1

Return Period in Years

PGA in g units	Guatemala City (1)	Quezal-tenango (2)	Mazaten-ango (3)	Chiquimula (4)	Puerto Barrios (5)	Escuintla (6)	San Marcos (7)	Coban (8)
0.05	1	1	1	10	20	1	1	9
0.10	13	8	13	37	41	11	17	37
0.15	23	37	26	82	72	21	38	124
0.20	36	76	53	158	120	32	76	192
0.25	44	153	103	302	225	63	141	287
0.30	52	248	205	441	297	178	250	432
0.35	86	337	325	571	385	381	361	696
0.40	393	448	540	731	494	571	468	1848
0.45	603	604	1254	933	645	807	610	
0.50	1620	818		1201	813	1302	820	
0.55	2169	1183		1583	990		1186	
0.60		2238		2198	1213		2248	
0.65				3472	1504			
0.70					1921			
0.75					2607			
0.80					4177			

0.20g peak ground acceleration will be exceeded. Consider again Table 5-1. For seismic zoning purposes, the following statements can be made:

The return period corresponding to a peak ground acceleration of 0.20g in Guatemala City is 36 years, in Escuintla is 32 years, in Quezaltenango and San Marcos is 76 years, in Mazatenango is 53 years, in Puerto Barrios is 120 years and in Chiquimula is 158 years. Thus, for each city, a graph relating the peak ground acceleration and return period can be plotted. Figures 5-1 through 5-9 show these graphs. They are referred to hereafter as Acceleration Zones Graphs. Figure 5-1 shows return period vs. peak ground acceleration for all the cities. It can be seen that for a given return period event (say, 100 years), Chiquimula has the lowest value of peak ground acceleration (≈ .16g) and Guatemala City has the highest value of peak ground acceleration (.36g). The values for other cities lies between these two limits. Qualitatively, it can be said that for a facility requiring a design loading corresponding to a 200 year return period, Chiquimula and Puerto Barrios have the lowest seismic zoning requirement; San Marcos, Quezaltenango, Mazatenango and Escuintla have similar zoning requirement; and finally, the highest level is for Guatemala City. This type of graph can help in macrozoning a country for a given class and use of a structure or facility.

V-2 Seismic Risk Zoning

In the previous section, we have seen the relationship between the peak ground acceleration and the corresponding return period for different cities of Guatemala. However, these relationships by themselves do not help in selecting a return period for a given acceptable level of risk. The next step, in any seismic zoning procedure, is to obtain a relationship between the economic (or exposure) life of a structure, the level of risk one is willing to take, and the return period consistent with the

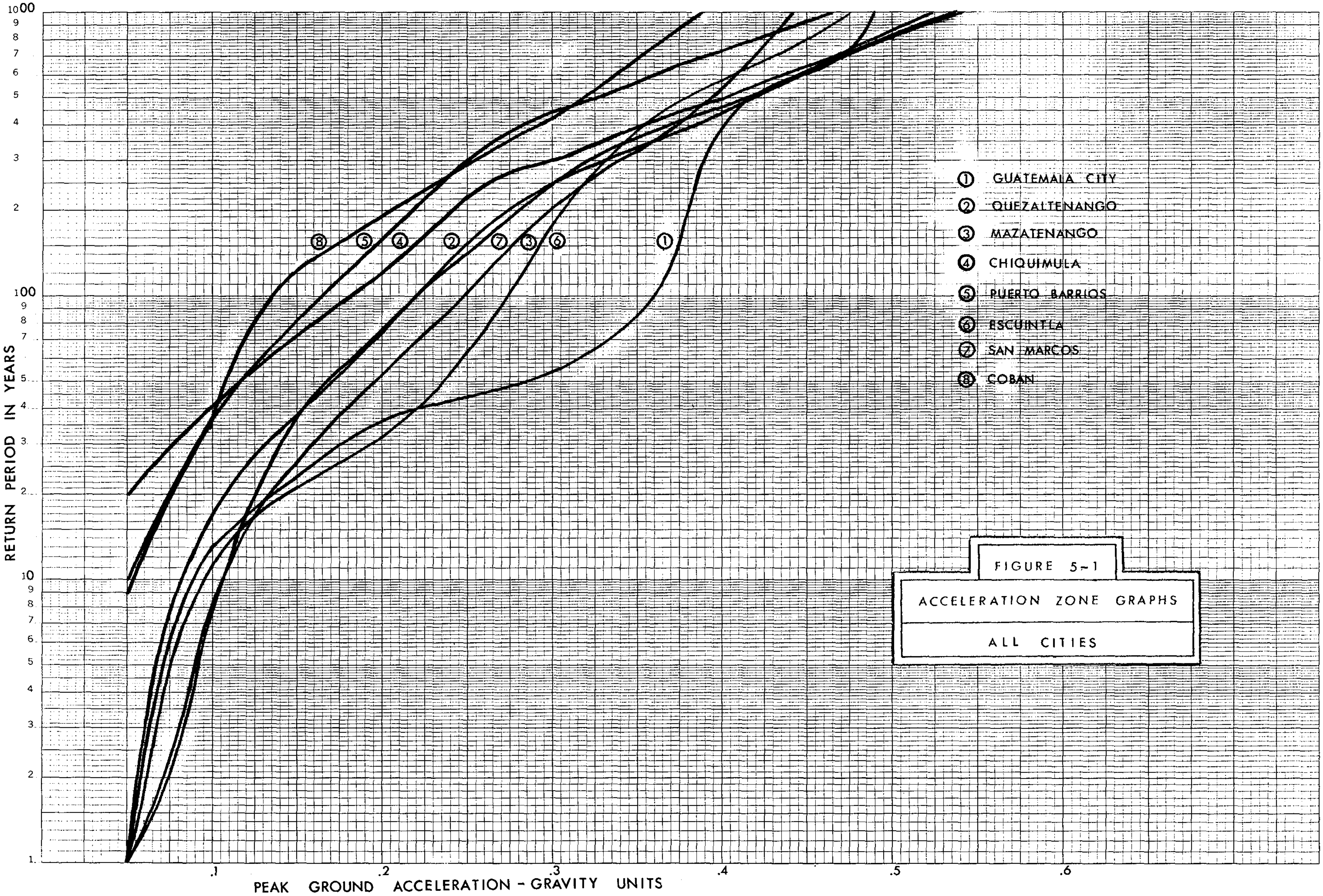


FIGURE 5-1

ACCELERATION ZONE GRAPHS

ALL CITIES

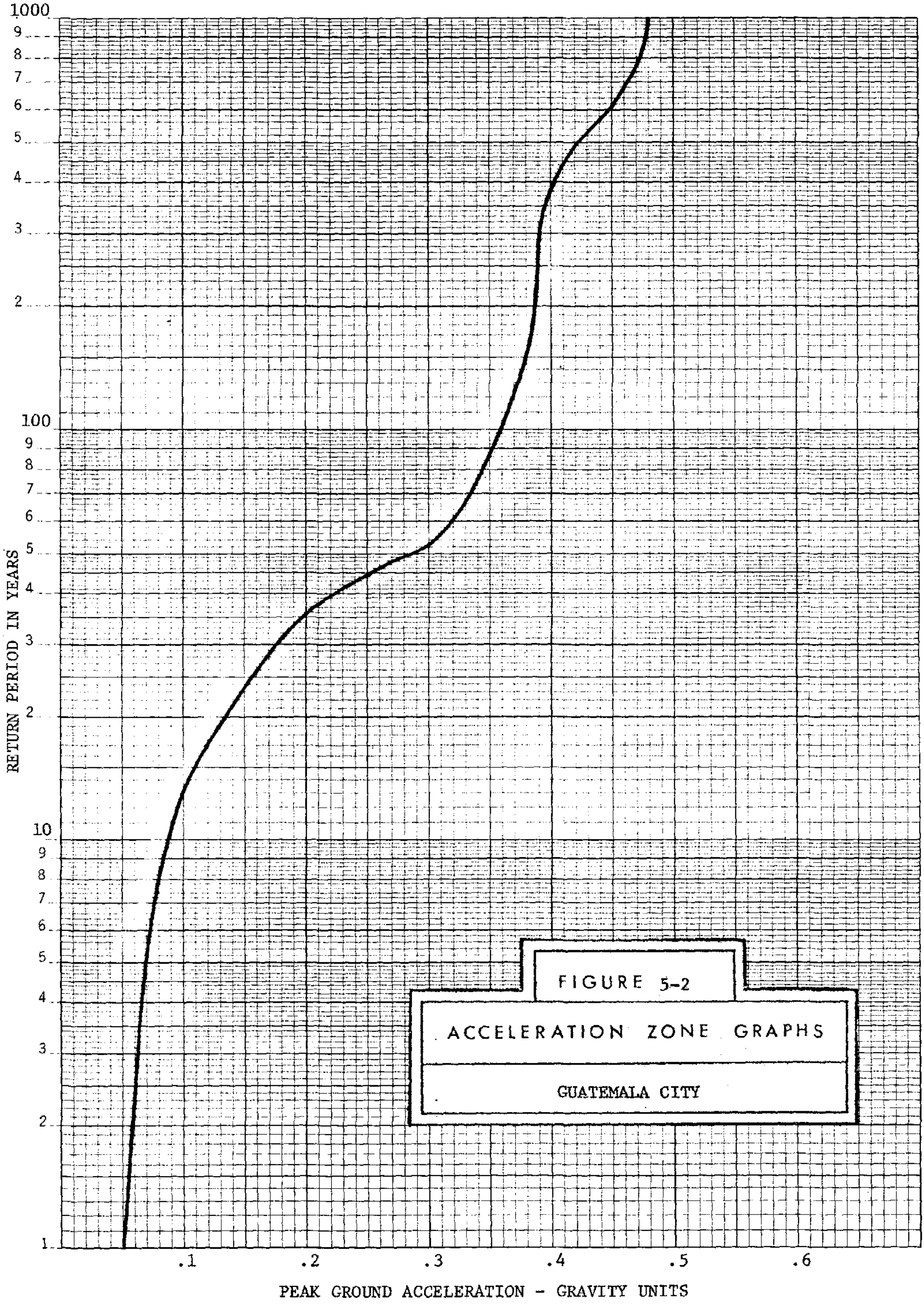


FIGURE 5-2

ACCELERATION ZONE GRAPHS

GUATEMALA CITY

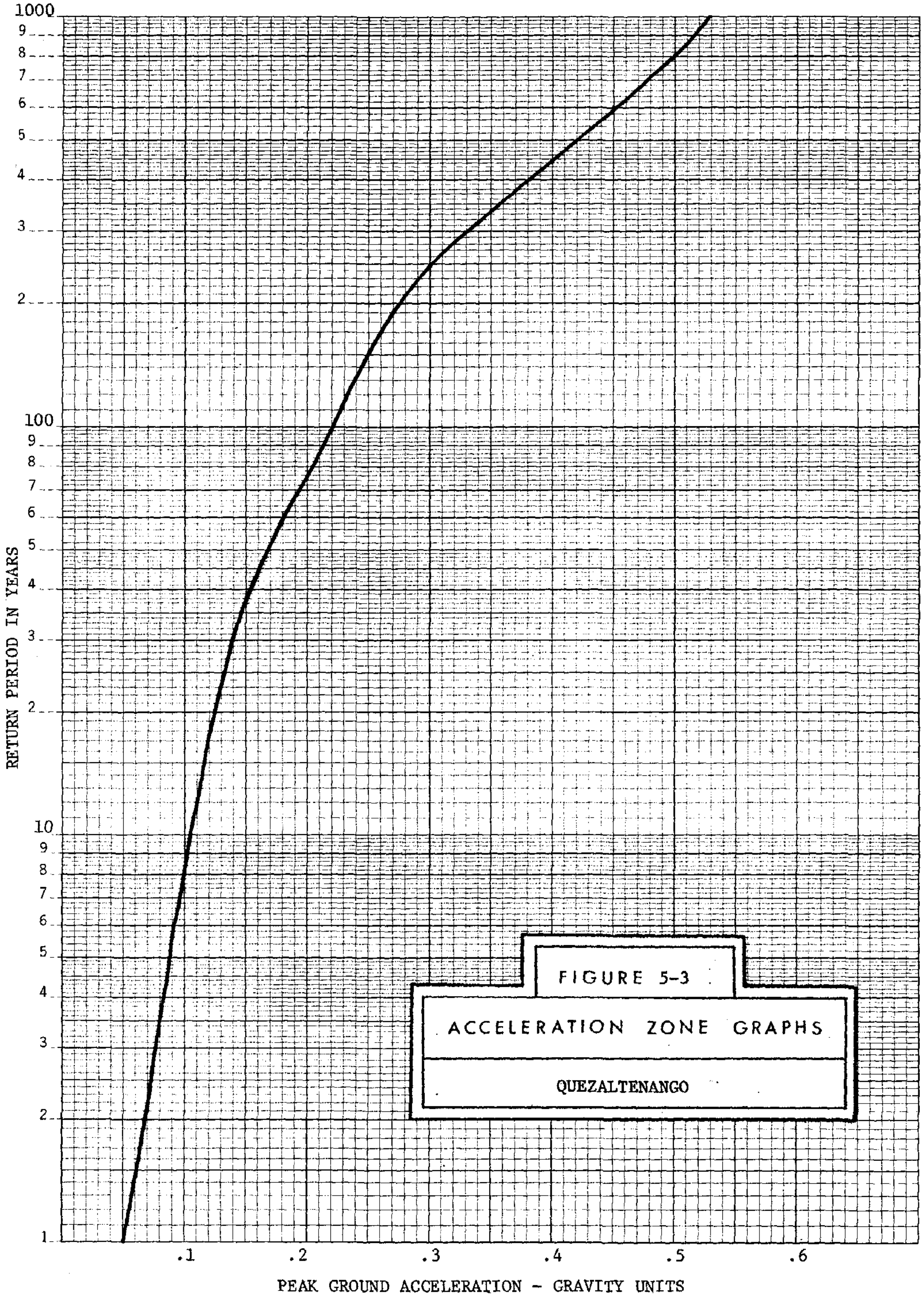


FIGURE 5-3

ACCELERATION ZONE GRAPHS

QUEZALTENANGO

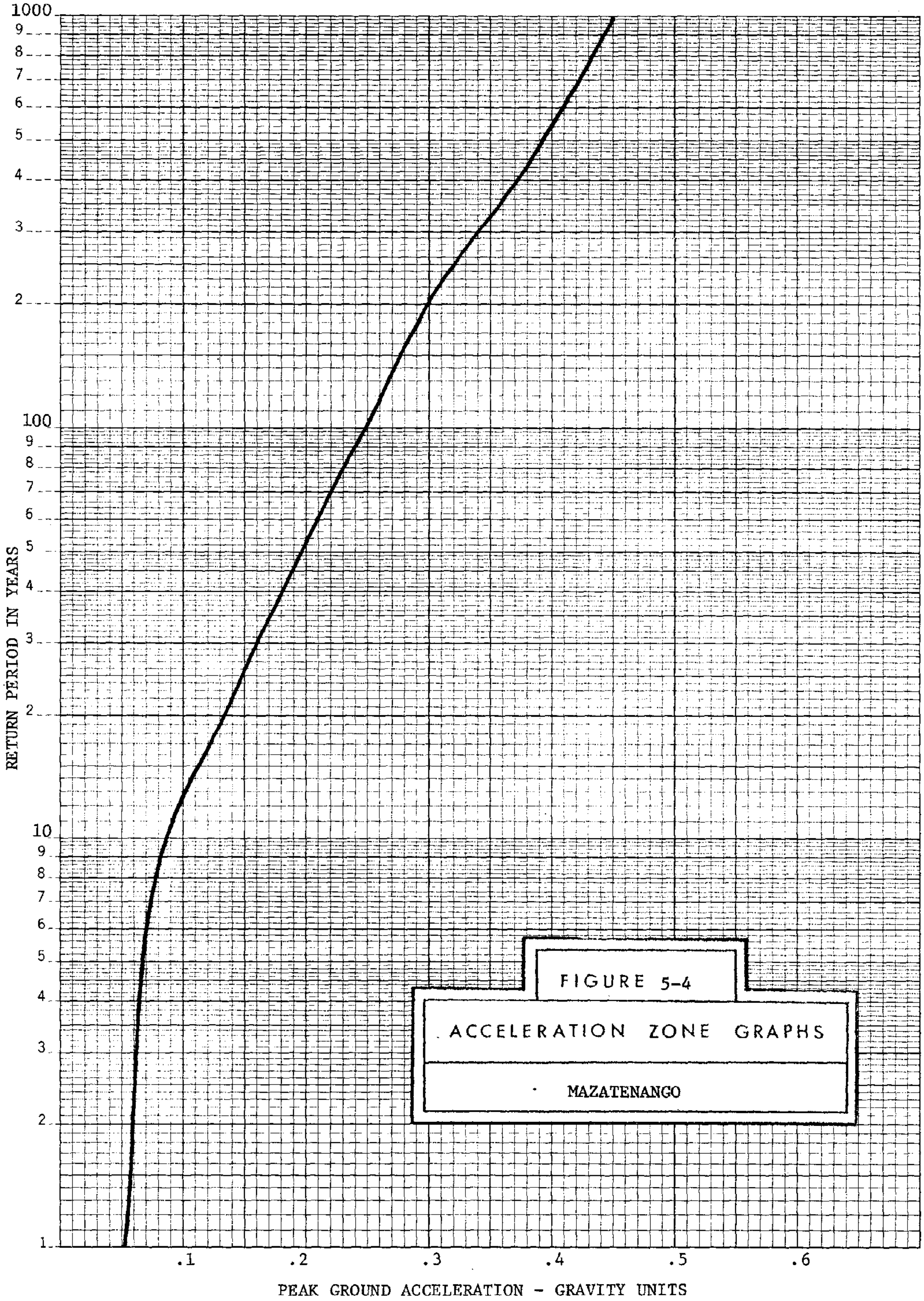


FIGURE 5-4

ACCELERATION ZONE GRAPHS

MAZATENANGO

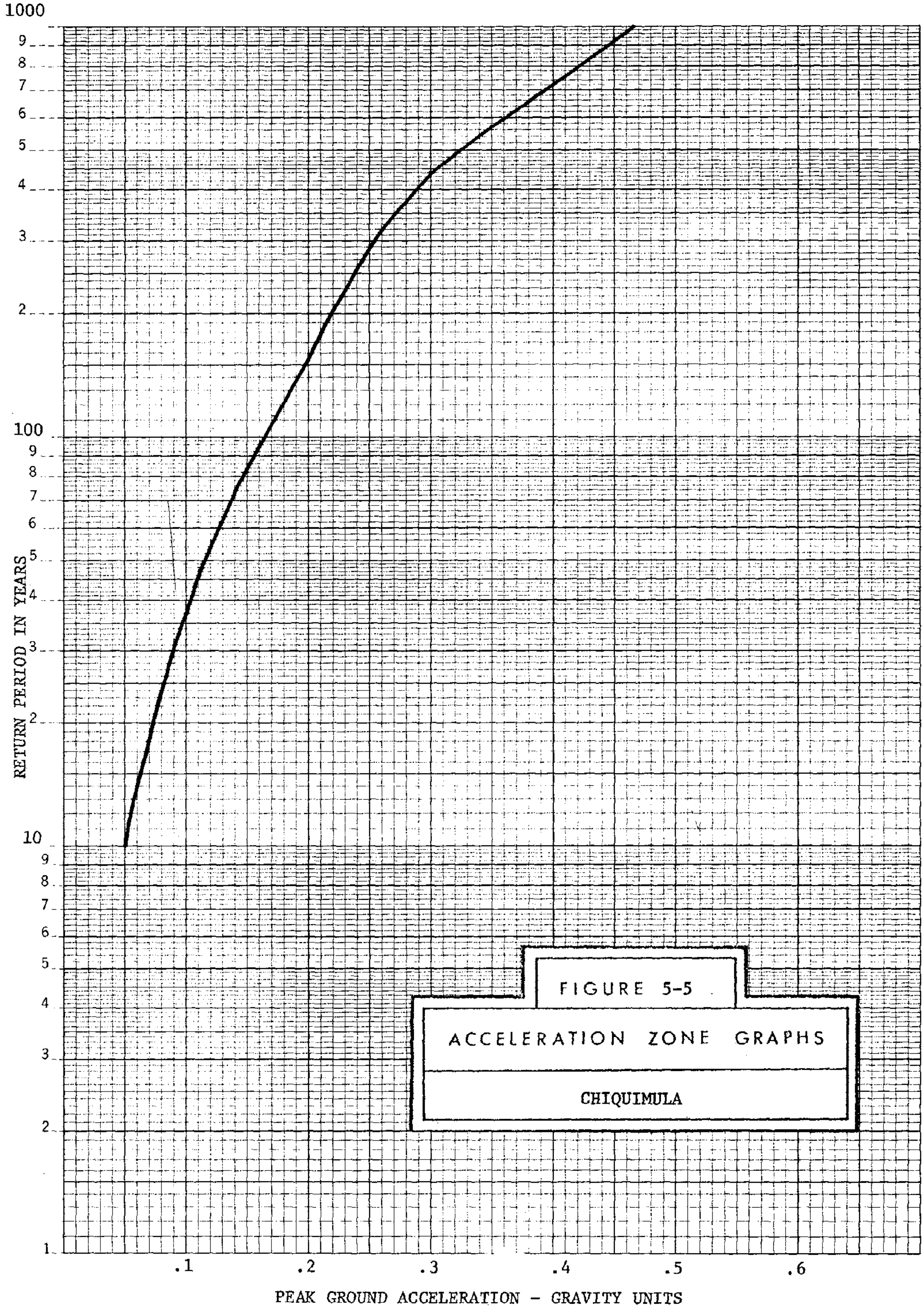


FIGURE 5-5

ACCELERATION ZONE GRAPHS

CHIQUIMULA

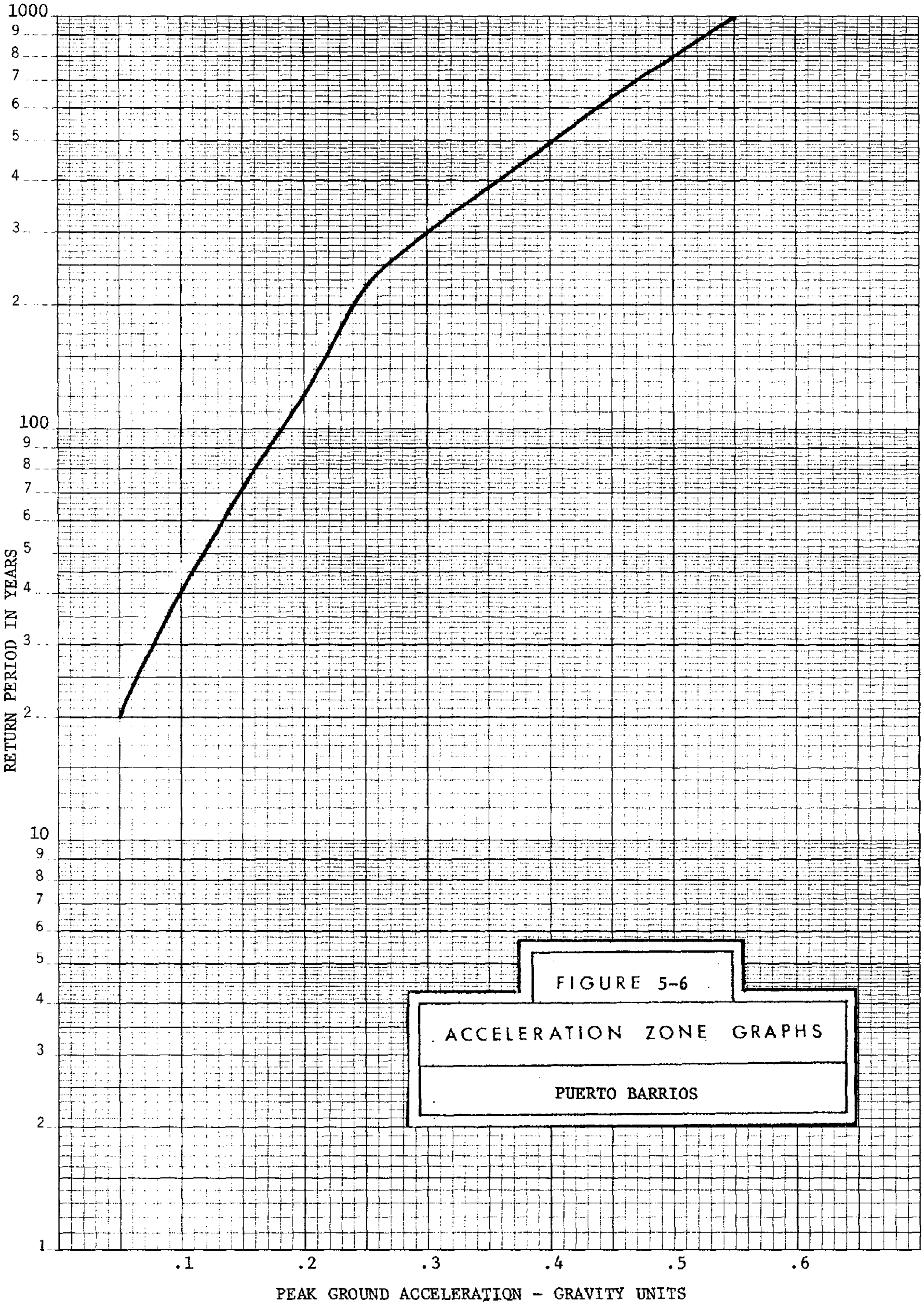


FIGURE 5-6

ACCELERATION ZONE GRAPHS

PUERTO BARRIOS

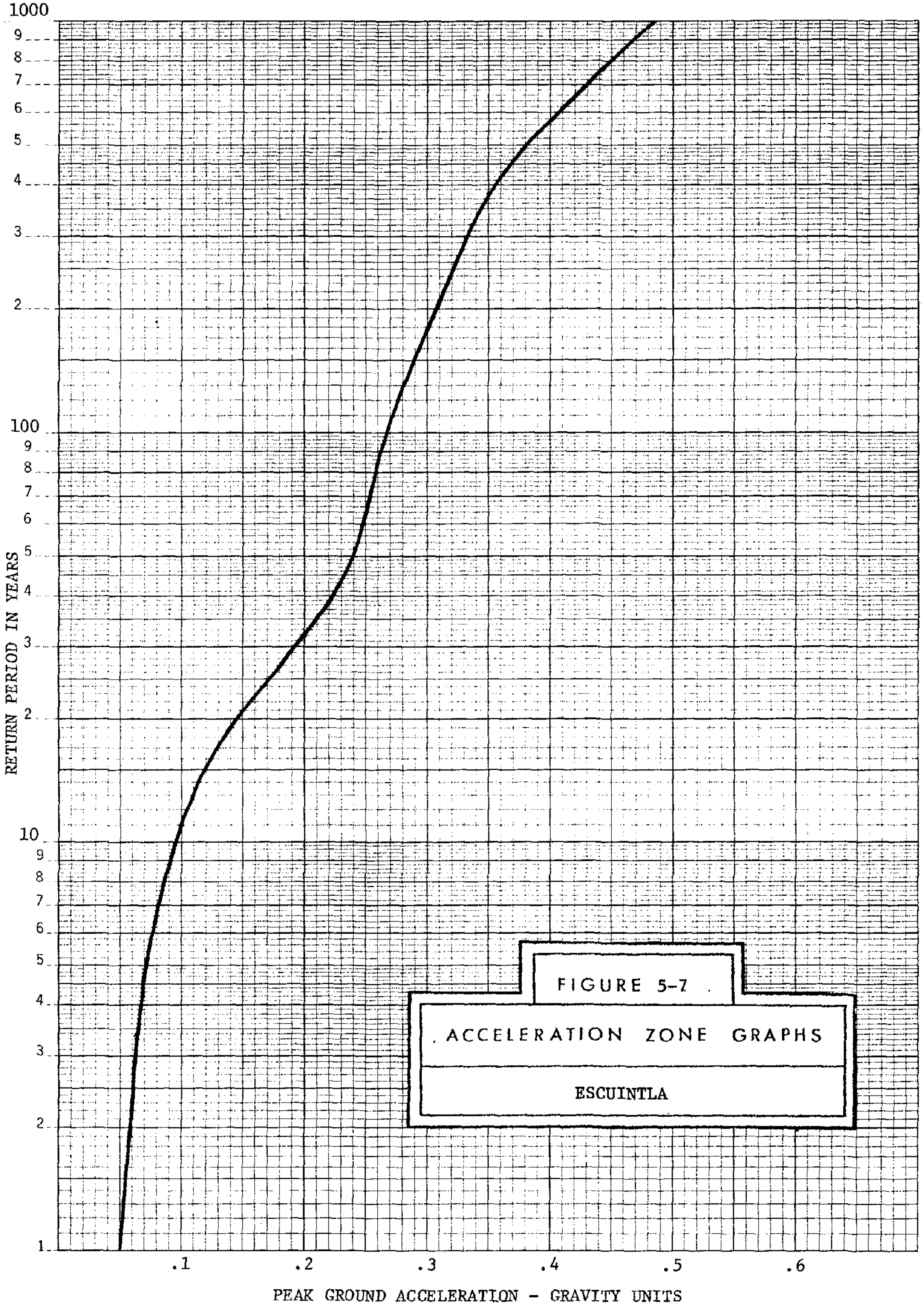


FIGURE 5-7

ACCELERATION ZONE GRAPHS

ESCUINTLA

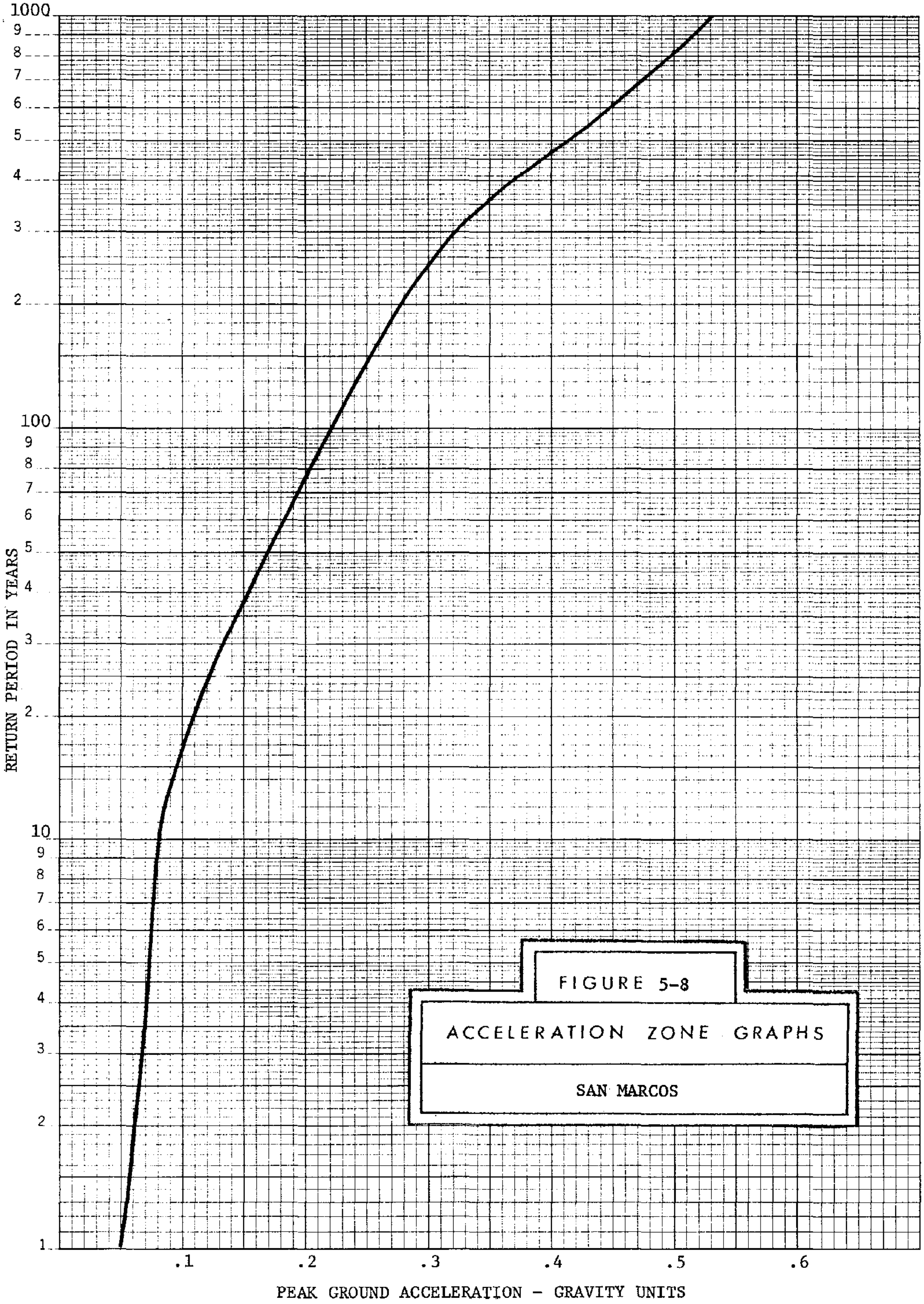


FIGURE 5-8

ACCELERATION ZONE GRAPHS

SAN MARCOS

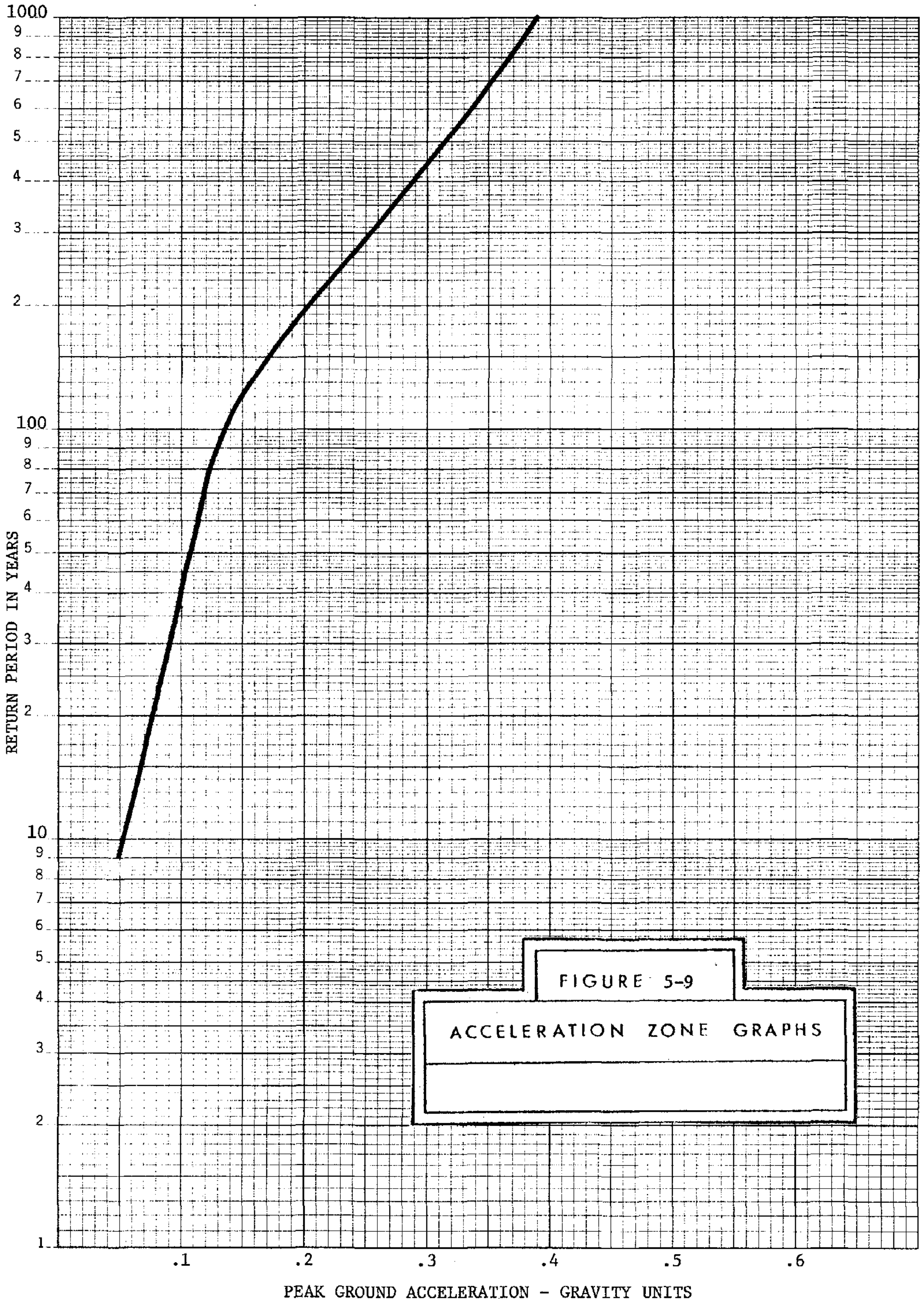


FIGURE 5-9

ACCELERATION ZONE GRAPHS

risk and economic life. Consider again the Binomial distribution. The probability of r successes in n independent Bernoulli trials, with probability p of success at each trial, is given by

$$p_n(r) = \binom{n}{r} p^r (1-p)^{n-r} \qquad \text{Eq. 5-2 repeated}$$

Thus

$$p_{10}(0) = \binom{10}{0} (p)^0 (1-p)^{10}$$

$$= (1-p)^{10} = \text{probability of zero successes in ten trials (years).}$$

Let $p(0) = (1-p)^{10}$ be equal to 0.90. Then the probability of no occurrence (or success) of a certain level of loading in ten years is given by 0.90.

or

$$(1-p)^{10} = 0.90$$

Hence

$$p = .01048$$

or return period RP = 95 years.

Thus, for a structure whose economic life is ten years, if the acceptable risk level is 10% of exceeding the specified loading level, then the structure should be designed for a return period of 95 years. Table 5-2 gives the relationship between acceptable risk level, economic life and return period. If, for example, the acceptable risk level is 20% for a structure whose economic life is 50 years, then the loading level should correspond to a return period of 225 years. If this structure is in Guatemala City, the corresponding peak ground acceleration level is approximately 0.39g. If the same facility for the same risk level is to be built in Puerto Barrios, the corresponding peak ground acceleration level should be approximately 0.25g. Thus, for a given class and use of structure, having the same economic life (50 years) and same acceptable risk (20%), the two consistent values of peak ground accelerations in Guatemala City and Puerto Barrios are 0.39g and 0.25g. This is the concept of consistent risk design from one seismic region to another region of different seismicity. Figure 5-10 shows the graph relating the risk level, economic life and the return period. This particular graph is independent of any region and gives return periods only as functions of risk and economic life. Such graphs can easily be codified. Once the acceptable risk level for a given economic life is selected for a given class and use of a structure, the corresponding return period is immediately obtained from Figure 5-10. Then, based on the graph of return period vs. peak ground acceleration (similar to Figures 5-1 to 5-9), the loading at a site can be determined. Let us describe this concept of risk, economic life, return period and Acceleration Zone Graphs (AZG).

As an example, consider a design of a hospital facility. Assume that the exposure time or economic life of the system is 50 years. The peak ground acceleration level for which this facility should be designed for each of three different cities is to be determined. The cities are Guatemala City, Quezaltenango and Puerto Barrios. Assume that for the hospital, which is a critical facility that must remain functional after a seismic event, the acceptable level of risk corresponding to damage is 20%. Thus, whether the planned facility is in Guatemala City, Quezaltenango, or Puerto Barrios, the engineers are willing to accept a 20% chance of damage during the 50 years economic life of the structure. Then, from Figure 5-10, the return period corresponding to the 50 year economic life and 20% risk is 225 years.

Now refer to the AZG corresponding to Guatemala City (see Figure 5-2). The peak ground acceleration for a 225 year return period in Guatemala City

TABLE 5-2

Return Period as a Function of Economic Life and Probability of Non-exceedence

Economic Life Years / Probability of exceeding %	10	20	30	40	50	100
10	95	190	285	390	475	950
20	45	90	135	180	225	449
30	29	57	84	113	140	281
40	20	40	59	79	98	196
50	15	29	44	58	72	145
60	11	22	33	44	55	110
70	9	17	25	34	42	84
80	7	13	19	25	31	63
90	5	9	14	18	22	44
95	4	7	11	14	18	34
99	3	5	7	9	11	22
99.5	2	4	6	8	10	19

is 0.39g. Similarly, referring to the AZG for Quezaltenango and Puerto Barrios, the peak ground acceleration values corresponding to the 225 year return period are 0.29g and 0.25g, respectively. Thus, these three values of peak ground acceleration in the three different cities are consistent with the given acceptable risk.

As an alternate situation, consider two separate classes of structures to be built in Guatemala City. Let a school building with an economic life of 30 years have an acceptable risk level of 20%, and a warehouse with a ten year economic life have a 40% acceptable risk level. Referring to Figure 5-10, the return period for which the school should be designed is 135 years, and the return period for which the warehouse should be designed is 20 years. Again from the Guatemala City AZG (Figure 5-2), the corresponding peak ground acceleration values are 0.37g and 0.14g for the school and warehouse, respectively. If the same two facilities were to be loacted in Chiquimula, the corresponding peak ground acceleration values would be 0.19g and 0.07g. The major advantage of this method of zoning is that one can keep a consistent risk level from one region to another. Variations in the economic life and acceptable risk levels can be accounted for in arriving at a loading level through the return period transformation. Further application of the AZG to structural design will be presented in Part II of the total study.

It should also be pointed out that even though Puerto Barrios and Quezaltenango have smaller values of PGA corresponding to lower return periods (100 years and 200 years), the potential for major ground shaking -- above 0.5g -- does exist as can be seen from the AZG of these two cities. Thus, in terms of maximum credible ground shaking, Puerto Barrios and Quezaltenango are the two cities which should be kept in mind.

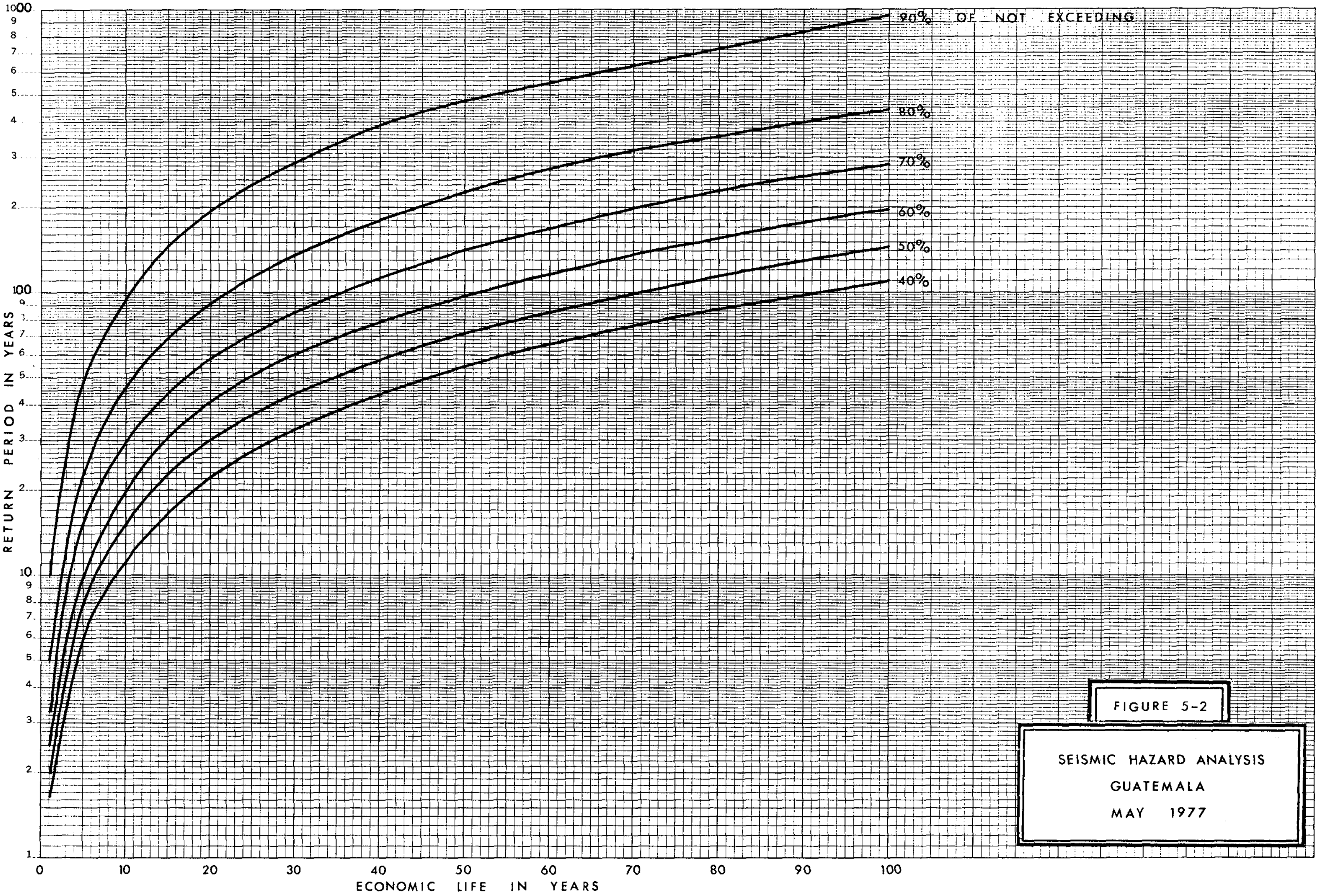


FIGURE 5-2

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

V-3 Concluding Remarks on Seismic Hazard Maps

Unlike the older seismic zone maps (such as the 1973 Uniform Building Code "risk" map) the recommended hazard map takes into account the frequency of seismic events, the level of "risk" one is willing to take in selecting a specific peak ground acceleration value and the future time horizons for which one wishes to consider the economic or structural life of the facility being designed.

Various questions come up regarding the reliability and long range stability of such hazard maps. Some of the questions are:

1. How reliable are the maps that are developed based on only historical data?
2. How stable are such maps? In other words, will these hazard maps change dramatically with each new future seismic event?
3. Is the formulation such that any new information available in the future can be incorporated to update the hazard maps?
4. What is the effect of local site conditions on the values obtained from these maps?

These and many such questions were discussed in Shah et al. (1975). However, in summary, the following responses can be be given to the four questions posed above.

With respect to the reliability of results based on historical data, it is felt that for engineering and planning purposes and for seismic code formulation, the results presented are sufficiently reliable. The usual economic life of any engineered facility is usually less than 100 years to 200 years. In terms of geological time spans, this is a short period. Hence, we can assume that the geological processes during this short period are at a steady state. Hence, any information available from historical data can be extrapolated into similar time spans in the future. This discussion does not mean to imply that there are no errors introduced.

This possibility always exists. However, to wait for a complete geological information before developing a "seismic load" criteria for a country is unrealistic and impractical.

Concerning the stability of the hazard map, it is felt that the results presented here are quite stable. As long as the future seismic events can be assigned to any one of the sources considered in this work, the shape of the maps as well as the level of PGA's suggested should not change substantially. The only time the maps should be updated and changed is when a major seismic event occurs in a region where no previously known seismic source existed. In that case, the formulation and the computer programs are such that the suggested maps can be readily updated with the new information incorporated. Thus, in reply to the third question, such maps could be updated very easily. As a general recommendation, it is felt that such maps should be updated every five to seven years.

Effect of local site conditions (micro-characteristics) is usually felt in the amplitude of vibrations and in the frequency content of the vibration. The hazard map developed here is based on "average" soil condition. Thus, no site specific information is included in their development. In Part II of this study the effect of soft soil will be introduced. by changing the shape of the response spectrum to include higher period components. However, it should be pointed out that for important facilities such as dams, power plants, hospitals, etc., a site specific study should be conducted. Such information can then be used to modify the values suggested by the hazard map of this chapter.

In conclusion, it can be said that the seismic ground shaking hazard information developed in this study represents "a state-of-the-art" engineering solution. It is not the total information but it is one of the best that can be developed with the available knowledge and resources.

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CHAPTER VI

SUMMARY, CONCLUSION AND FURTHER RESEARCH

Scope

This chapter summarizes the work done in this phase of the study regarding the seismic hazard mapping of Guatemala. The conclusions drawn from this work are presented and a summary look at the phase 2 of this study is introduced.

....

VI-1 Summary of Work on Seismic Hazard Mapping

In evaluating the future seismic hazard for Guatemala, the general geologic setting of the country, the seismological environment and all the available historical data was reviewed in this report. Two types of models were used in developing the seismic hazard maps (or iso-acceleration maps) of the country. The first model was the Poisson occurrence model where the seismic recurrence for various sources was based on past earthquake data and on a hypothesized upper Richter magnitude. Chapter IV presents these maps for four separate return periods. In Part II of this study, the relevance of obtaining iso-acceleration maps for the four return periods (50, 100, 500 and 1000 years) will be discussed. The Bayesian model, where subjective and objective information on the number of occurrences and the magnitude level is used, is presented in the Appendix B. For this model the attenuation relationship is assumed to be probabilistic with Uniform distribution and the scatter of this distribution is represented by the coefficient of variation. Iso-acceleration maps developed using this Bayesian model are also given in Appendix B. For further details on this

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model and its application see Mortgat (1976) and Mortgat et al. (1977).

Using the Bayesian model, iso-duration maps are also presented in the Appendix B. At this time, explicite use of duration in seismic design decisions is not available. However, it is felt that this information is an important engineering input and will be of great interest to planners and engineers.

Based on the information from iso-acceleration maps, the acceleration zone graphs (AZG) for the following eight major urban areas was developed.

1. Guatemala City
2. Quezaltenango
3. Mazatenango
4. Chiquimula
5. Puerto Barrios
6. Esquintla
7. San Marcos
8. Copan

These acceleration zone graphs can be used to evaluate the level of peak ground acceleration as a function of return period. In a future report on phase 2 of this study, the suggested levels of peak ground accelerations for various regions of the country and for various types and uses of structures will be presented.

VI-2 Conclusions from the Present Study

It is very interesting to note that the shape of the iso-acceleration maps obtained by using the Bayesian model (Appendix B) and the Poisson occurrence model are very similar. This is due to the following reasons:

1) The data base used for both models is the same.
2) The subjective data of the Bayesian model was developed from the regression line of the recurrence curve obtained in the Poisson occurrence model.

The value of the peak ground acceleration obtained using the Bayesian model will increase with the increase in attenuation uncertainty. The coefficient of variation used in the Appendix B maps was 0.3. Looking at this similarity and based on experience obtained in developing Nicaragua iso-acceleration maps (Shah et al., 1975) and Costa Rica iso-acceleration maps (Mortgat et al., 1977) it is reasonable to accept the iso-acceleration maps for various return periods presented in Chapter IV.

The iso-duration maps given in Appendix B can be used to evaluate damage potential and energy content of future hypothesized or forecasted seismic events.

It can be concluded from the results presented in this report that for engineering planning, sufficient data are available (together with geological information and subjective knowledge) to provide seismic "zoning" information for Guatemala. The methods presented in this report can use either objective or subjective seismological data. The method is simple and has the capabilities of being updated at regular intervals. It can be seen from the iso-acceleration maps of Chapter IV that the seismicity in the northern part of Guatemala is low. The high seismic region of the south-southwestern part of Guatemala reaches a peak near the intersection of the Motagua fault, the Benioff Zone and the Mixco fault. The probable seismic "loading" in Guatemala City, based on the available data and the resultant iso-acceleration maps, is high. In comparison to the Managua region of Nicaragua, the Guatemala City region is very similar. The seismic lateral load requirement for these various levels of peak ground accelerations will be developed in Part II of this study.

In Chapter V, the reliability and stability of the iso-acceleration maps was discussed. It should be noted once more here that the methodology available now can take into account not only the short historical data, but also any geological or seismological information that may be available. It is felt by the authors of this report that such maps should be updated every five years so that any new information that will be available can be incorporated in the updated version.

In conclusion, it can be said that the seismic ground shaking hazard information in the form of iso-acceleration and iso-duration maps developed in this study represents the "state-of-the-art" methodology and engineering solution. It is consistent with the available information. Thus, its shortcomings are also consistent with the shortcomings of the available data. It is always possible that the results obtained by using the past knowledge can always be proven to be incorrect by the nature.

VI-3 Further Research

In order to implement and use the seismic hazard information presented in this report, the following topics and tasks will be accomplished in part II of this study:

- A thorough study of the 1973 UBC, the 1976 UBC and the ATC-3 work currently being completed. The above codes will be evaluated with the seismicity of Guatemala in mind. Such an evaluation will permit the engineers and planners in Guatemala to appreciate and understand the current code levels and their relationships with future seismic loading demands.
- A detailed discussion on the purpose and effects of earthquake codes will be presented. This will include the history of earthquake loading criteria, the relation of design loads and quality of structures, the objectives and qualities of workable seismic codes and the role of design detailing and design forces in providing a safe economic construction.

- Introduction to the Proposed Seismic Design Provisions. This will take into account the current codes, their advantages, their shortcomings and the available solutions to eliminate or reduce the shortcomings. This part of the study will explain in detail the concept of acceptable risk and the associated loading levels from the hazard maps of Guatemala. The study will also develop the shape and levels of various design spectra. These spectra will include the site characteristics information.
- A detailed description of the type of structural systems, their effects on the design level and a step-by-step design procedure will be developed.
- Based on the spectral approach of seismic design, a simplified equivalent static load method, similar to the 1976 UBC method of design, will be developed. It should be emphasized here that a workable code should have the following four ingredients.
    1) Simplicity.
    2) Rationality.
    3) Freedom to use responsible ingenuity for special structures.
    4) Reward and encouragement for using dynamic analysis when merited by the complexity of a given structure.

  In developing the methodology in Part II of this study, the above four ingredients will be kept in mind.
- Finally, a detailed comparison with the proposed methodology and the 1976 UBC will be made. This will be done with the seismic environment of Guatemala (as obtained in this report) in mind.

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REFERENCES

Agocs, W. B., 1958, Results of Airborne Magnetometer Profile from Brownsville, Texas to Guatemala City, Geophysics, V23, pp. 726-737.

Algermissen, S. T. and Perkins, D. M., June 4-5, 1975, Earthquake Risk Studies in the Branch of Seismicity and Risk Analysis, talk given at the U.S.G.S. Earthquake Studies Advisory Panel, Colorado School of Mines, Golden, Colorado.

Anderson, T. H., et al., 1973, Geology of the Western Altos Cuchumatanes, Northwestern Guatemala, Geological Society of America Bulletin V84, No. 3, pp. 805-826.

Benjamin, J. and Cornell, C. A., 1970, "Probability, Statistics and Decision for Civil Engineers", McGraw-Hill Book Company, New York.

Bilodeau, W. L., 1976, Tectonics of Northern Central America, Unpublished.

Bolt, B. A., 1973, Duration of Strong Motion, Proceedings of the Fifth World Conference on Earthquake Engineering, Paper 292, Rome.

Bonis, S. B., 1969, A Summary of the Geology of Guatemala.

Bonis, S. B., et al., 1970, Mapa Geologico de la Republica de Guatemala, Instituto Geografico Nacional, 1:500,000.

Carr, M. J., 1976, Underthrusting and Quaternary Faulting in Northern Central America, Geological Society of America, Bulletin V87, No. 5, pp. 825-829.

Carr, M. J., Stoiber, R. E., Drake, C. L., 1974, The Segmented Nature of Some Continental Margins, The Geology of Continental Margins, pp. 105-114.

Cornell, C. A. and Vanmarcke, E. H., 1969, The Major Influences on Seismic Risk, Proceedings of the Fourth World Conference of Earthquake Engineering, Vol. 1, Chile.

Dalal, J. S., February 1973, Probabilistic Seismic Exposure and Structural Risk Evaluation, Technical Report No. 169, Dept. of Civil Engineering, Stanford University.

Dengo, G., 1968, Estructura Geologica, Historia Tectonica, y Morfologice de America Central, Centro Regional de Ayuda Tecnica.

Dengo, G., et al., 1970, Tectonics and Volcanism along the Pacific Marginal Zone of Central America, Geol. Rundschau V59, No. 3, pp. 1215-1232.

Dengo, G., Bohnenberger, O., 1969, Structural Development of Northern Central America, in Am. Assoc. Petroleum Geologists Mem. No. 11, pp. 203-220.

Donovan, N., December 1974, Earthquake Hazard for Buildings, Dames & Moore Engineering Bulletin 46, Dames & Moore, Los Angeles.

Espinosa, A. F., 1976, The Guatemalan Earthquake of February 4, 1976, A Preliminary Report, U. S. Geological Survey Prof. Paper 1002.

Fiedler, B, G.E., 1976, Guatemala - The Motagua Fault Earthquake of February 4, 1976, Venezuela Ministerio de la Defensa.

Gardner, J. K. and Knopoff, L., October 1974, Is the Sequence of Earthquakes in Southern California, with Aftershocks Removed, Poissonian?, Bull. of the Seismological Society of America, Vol. 64, No. 5.

Guzman, E. J. and De Cserna, Z., 1961, Tectonic History of Mexico, Backbone of the Americas, AAPG Memoir #2.

Jordan, T., 1975, The Present Day Motions of the Caribbean Plate, in Journ. of Geophysical Research V80, No. 32, pp. 4433-4439.

Kiremidjian, A. S. and Shah, H., C., November 1975, Seismic Hazard Mapping of California, The John A. Blume Earthquake Engineering Center, Report No. 21, Dept. of Civil Engr., Stanford University.

Kupfer, D. H., Goday, J., 1967, Strike Slip Faulting in Guatemala, American Geophysical Union Transactions V48, p. 215.

Lomnitz, C., 1974, Global Tectonics and Earthquake Risk, Elsevier Scientific Publishing Co.

McBirney, A. R., 1963, Geology of a Part of the Central Guatemalan Cordillera, Univ. of Calif. Published in Geol. Sciences V38, pp. 177-242.

Meyer-Abich, H., Mooser, F., McBirney, A. R., 1958, Catalogue of the Active Volcanoes of the World, Part VI - Central America, International Volcanological Assoc.

Meyerhoff, A. A., 1962, Bartlett Fault System: Age and Offset, in Trans. of the Third Caribbean Geol. Conference, Geological Survey Jamaica Publication No. 95, pp. 1-9.

Molnar, P. and Sykes, L., 1969, Tectonics of the Caribbean and Middle America Region from Focal Mechanisms and Seismicity, in Geol. Soc. of America Bulletin V80, pp. 1639-1684.

Mortgat, C. P., December 1976, A Bayesian Approach to Seismic Risk; Development of Stable Response Parameters, Ph.D. Dissertation, Dept. of Civil Engineering, Stanford University, Stanford, California.

Mortgat, C. P., et al., 1977, A Study of Seismic Risk for Costa Rica, The John A. Blume Earthquake Engineering Center, Rerport No. 25, Dept. of Civil Engineering, Stanford University.

Muehlberger, W. R., Ritchie, A. W., 1975, Caribbean-Americas Plate Boundary in Guatemala and Southern Mexico as seen on SKYLAB IV Orbital Photography, in Geology V3, No. 5, pp. 232-235.

Nichols, D. R. and Buchanan-Banks, J. M., 1974, Seismic Hazards and Land-Use Planning, U. S. Geological Survey Circular 690.

Plafker, G. and Bonilla, M. G., 1976, Geologic Field Studies, in Interim Report on the Guatemalan Earthquake of Feb. 4, 1976, and the Activities of the USGS Earthquake Investigation Team, edited by Page, R. A.

Schuchert, C., 1935, Historical Geology of the Antillean-Caribbean Region, John Wiley & Sons, Inc.

Shah, H. C., et al., 1957, A Study of Seismic Risk for Nicaragua, Part I, J. A. Blume Earthquake Engineering Center Report No. 11.

Shah, H. C., et al., 1976, A Study of Seismic Risk for Costa Rica, in preparation.

"Uniform Building Code", 1973 Edition, International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90607.

"Uniform Building Code", 1976 Edition, International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90607.

Vagliente, V. N., June 1973, Forecasting the Risk Interest in Earthquake-Resistant Design, Technical Report No. 147, Dept. of Civil Engr., Stanford University.

Vassaux, J. P., 1969, "Cincuenta Anos de Seismologia en Guatemala", Ministerio de Agricultura Direccion Recursos Naturales Renovables, Observaterio Nacional, Guatemala, Central America.

Vinson, G. L. and Brineman, J. H., 1961, Nuclear Central America, Hub of Antillean Transverse Belt, in Backbone of the Americas, AAPG Memoir #2.

Weyl, R., 1962, Orogenesis in Central America, in Trans Third Caribbean Geol. Conf., Geol. Survey Jamaica Publ. No. 95, pp. 91-94.

Wiggins, J. H., Procedure for Determining Acceptable Risk Ground Motion Design Criteria, Technical Report No. 75-1229, J. H. Wiggins Company, Redondo Beach, California, 1975.

Williams, H., 1960, Volcanic History of the Guatemalan Highlands, Univ. of Calif. Publ. in Geol. Sciences, Vol. 38, pp. 1-87.

Williams, H., McBirney, A. R., Dengo, G., 1964, Geologic Reconnaissance of Southeastern Guatemala, Univ. of Calif. Publ. in Geol. Sciences, V50, pp. 1-62.

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APPENDIX A

POISSON MODEL

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APPENDIX A

POISSON MODEL

A-1 Poisson Model of Seismic Occurrences

As mentioned in Chapter II, earthquake occurrences can be modeled using the Poisson probability law. For earthquake events to follow the Poisson Model, the following assumptions must be valid:

(1) Earthquakes are spatially independent;

(2) Earthquakes are temporally independent;

(3) Probability that two seismic events will take place at the same place and at the same instant of time approaches zero.

These assumptions are necessary for the formulation of the Poisson Model. The first assumption implies that occurrence or nonoccurrence of a seismic event at one site does not affect the occurrence or nonoccurrence of another seismic event at some other site. The second assumption implies that the seismic events do not have memory in time. A Markovian assumption of one-step memory in time may be a better assumption, but as mentioned previously, this assumption for large events does not introduce major errors (Gardner and Knopoff, 1974). The third assumption implies that for a small time interval, Δt, no more than one seismic event can occur. This assumption is considered to be realistic and to fit the physical phenomenon.

For events which satisfy the above assumptions, the Poisson law can be written as

$$P_n(t) = \frac{e^{-\lambda t}\,(\lambda t)^n}{n!} \qquad \text{A-1}$$

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where $P_n(t)$ = Probability of having n events in time period t.

n = Number of events.

λ = Mean rate of occurrence per unit of time.

In Chapter III, it was shown how the mean number of occurrences above magnitude M for a given source can be obtained using recurrence relationships. This relationship in its general form can be stated as

$$N(M) = \phi(M, A, T) \qquad \text{A-2}$$

where $N(M)$ = Number of occurrences above Richter magnitude M.

M = Richter magnitude.

A = Source characteristic (area for area source, length for line source).

T = Time period of data base.

As mentioned in Chapter III, a log-linear recurrence relationship is assumed for all sources. Also, for some sources, the relationship is bi-linear (two lines described by α_1, β_1, and α_2, β_2). (See Table 3-3 of Chapter III.) Thus, for a given source, the two lines describing the recurrence relationship are given by:

$$\begin{aligned} \ln N'(M) &= \alpha_1' + \beta_1 M & 0 \leq M \leq M_1 \\ \ln N'(M) &= \alpha_2' + \beta_2 M & M_1 \leq M \leq M_2 \end{aligned} \qquad \text{A-3}$$

where M_1 is the magnitude at which the two recurrence lines intersect (see, for example, Fig. 3-4).

M_2 is the upper cutoff magnitude for a given source (see Table 3-3, Chapter III).

Thus, depending on the source and the value of M, the mean number of events above magnitude M for a unit area for an area source, a unit length for a line source, and a unit time is given by:

$$N'(M) = \exp\,[\alpha_i' + \beta_i M] \qquad \text{A-4}$$

From equation A-1 it follows that

$$P_n(t) = \frac{\exp\,[-\exp\,(\alpha_i' + \beta_i M)t]\,[\exp\,(\alpha_i' + \beta_i M)t]^n}{n!} \qquad \text{A-5}$$

Note that in equation A-5 above, λ is replaced by $N'(M)$. Equation A-5 gives the probability of observing n events above magnitude M in time period t, based on the seismic history of a given source.

A-2 Source Mechanisms

Three different types of sources can be used to represent the seismicity of any region. They are point, line, and area sources. All three source mechanisms will be discussed for generality and completeness of the development, although only line sources were considered for the Guatemala region.

a. Point Source

For this type of source, all occurrences (past and future) take place at one point. The recurrence relationship can be normalized with respect to time T as follows:

$$N'(m) = \frac{N(m)}{T} \qquad \text{A-6}$$

Substituting the value of $N'(m)$ in the Poisson law, Equation A-1 becomes:

$$P_n[M > m,t] = \frac{\exp\,[-N'(m)t]\,[N'(m)t]^n}{n!} \qquad \text{A-7}$$

where the notation

$P_n[M > m,t]$ gives the probability that there will be n events of Richter magnitude greater than m in time period t.

For engineering purposes, it is of primary interest to determine the probability of at least one event greater then m in time period t. The probability is given by

P(at least one event of magnitude $M > m$ in time t)

$= 1 -$ P(no earthquake of magnitude $M < m$ in time t)

Hence, from Equation A-7

P(at least one event of magnitude $M > m$ in time t)

$$= 1 - \exp\,[-\,N'(m)t]$$

b. Line Source

In the case of a line source, it is assumed that epicenters lie along a linear fault pattern. For a line source of length L (fault length L) and a data base for a time period T, the recurrence relationship can be normalized to:

$$N'(m) = \frac{N(m)}{LT}$$ (Equation 3-3b repeated)

This N'(m) can be substituted directly in Equation A-8 to obtain the probability of at least one event of magnitude $M > m$ in time t.

c. Area Source

When the past earthquake epicenters do not lie on a line (i.e., along a given fault line) or when there is no information on fault locations, but earthquake events are scattered over a region, the seismic source should be con-

considered as an area source. The area source can be approximated by a full circle or any section of a circle in which the epicenters are scattered. In this case, the recurrence relationship is normalized with respect to the area A and the time of the data base T.

$$N'(m) = \frac{N(m)}{AT} \qquad \text{(Equation 3-3a repeated)}$$

Again, the probability of at least one event due to this area source above magnitude m in time period t is given by

$$P(\text{at least one } M > m \text{ in time } t) = 1 - \exp\left[-N'(m)t\right]$$

It should be noted that while Equation A-8 has the same form for a point source, line source and area source, in each case the normalized N'(m) has a different interpretation.

A-3 Peak Ground Acceleration at a Site

For design purposes, it is necessary to know the loading at a site. As mentioned in Chapter III, the most commonly used parameter to describe the seismic loading at a given site is the peak ground acceleration. In order to derive the probability distribution on peak ground acceleration at a site for a future time period t, the following information is required:

1. Probabilistic formulation on Richter magnitude for a source as a function of future time t.
2. Distance from the source to the site.
3. Attenuation of peak ground acceleration from source to site.

The first parameter has already been determined in the previous section. Various attenuation formulae are available which give the relationship between the Richter magnitude M, the epicentral distance or the hypocentral distance, and the peak ground acceleration. Donovan (1974) has summarized and compared ten attenuation relationships. These relations are repeated in Table A-1 and their graphs are shown in Figure A-1 Most of the relationships in Table A-1, can be written in the following general form:

$$a = \frac{b_1 \exp(b_2 m)}{(R_h + b_4)^{b_3}} \quad \text{A-9}$$

where a = Peak Ground Acceleration (PGA) in cm/sec^2 or g

R_h = Hypocentral distance from source to site in km or miles

m = Richter magnitude

b_1, b_2, b_3 and b_4 are constants depending on the region

Using the general form of the attenuation relationship given by Equation A-9, the probability distribution on peak ground acceleration for a site due to the three types of seismic sources can be obtained.

Point Source

The probability of at least one event greater than m in time t from a point source such as the one shown on Figure A-2 is:

$$P[M > m,t] = 1 - \exp\,[-N'(m)t] \quad \text{A-10}$$

Substituting the recurrence relationships given by Equation 3-2, the probability distribution is derived as follows:

$$P[M > m,t] = 1 - \exp[-\exp\,(\alpha' + \beta m)t] \quad \text{A-11}$$

where α' = normalized regression constant.

TABLE A-1

Attenuation Equations

	Data Source	Equation	Reference
1.	San Fernando Earthquake February 9, 1971	$y = 186206\ R^{-1.83}$	--
2.	California Earthquakes	$y = \frac{981\ y_o}{1 + \frac{R'}{h}^{2}}$ where $\log y_o = -(\bar{b}+3) + 0.81m - 0.027m^2$ $\bar{b}$ is a site factor	Blume (1965)
3.	California Earthquakes	Graphical Presentation	Housner (1965)
4.	California & Japanese	$y = \frac{5}{T_G}\ 10^{0.61m - P \log R + Q}$ where $P = 1.66 + \frac{3.60}{R}$ $Q = 0.167 - \frac{1.83}{R}$ T_G = fundamental period of site	Kanai (1966)
5.	Cloud (1963)	$y = \frac{6.77\ e^{1.64m}}{1.1e^{1.1m} + R^2}$	Milne & Davenport (1969)
6.	Cloud (1963) Housner (1962)	$y = 1230\ e^{0.8m}\ (R+25)^{-2}$	Esteva (1970)
7.	U.S.C. & G.S.	$\log_{10} y = 6.5 - 2 \log_{10} (R'+80)$	Cloud & Perez (1971)
8.	11 Selected Records	Graphical Presentation	Schnabel & Seed (1972)
9.	303 Instrumental Values	$y = 1300\ e^{0.67m}\ (R+25)^{-1.6}$	--
10.	Western U. S. Records	$y = 18.9\ e^{0.8m}\ (R^2+400)^{-1}$	--

y is cm/sec^2
R is kilometers (distance to causative fault)
R' is miles (epicentral distance)
h is miles (focal depth)
m is magnitude

* Taken from Donovan 1974

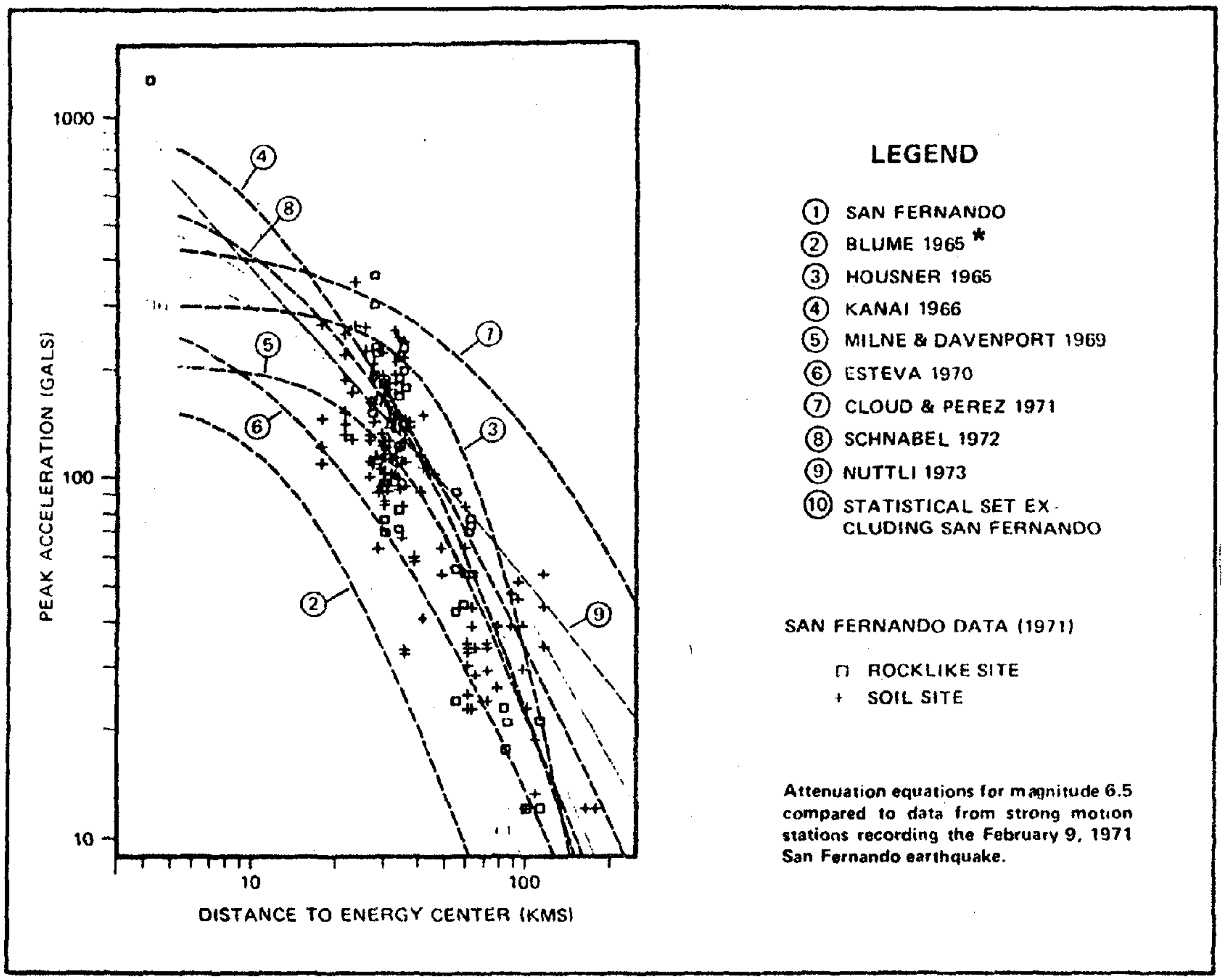

FIGURE A-1a Attenuation Relationships.
(Taken from Shah et al., 1975).

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* This relation can provide results which are very close to mean data behavior if the soil characteristics for the region are recognized. The soil characteristics input was not used in the preparation of this figure from Shah et al., 1975.

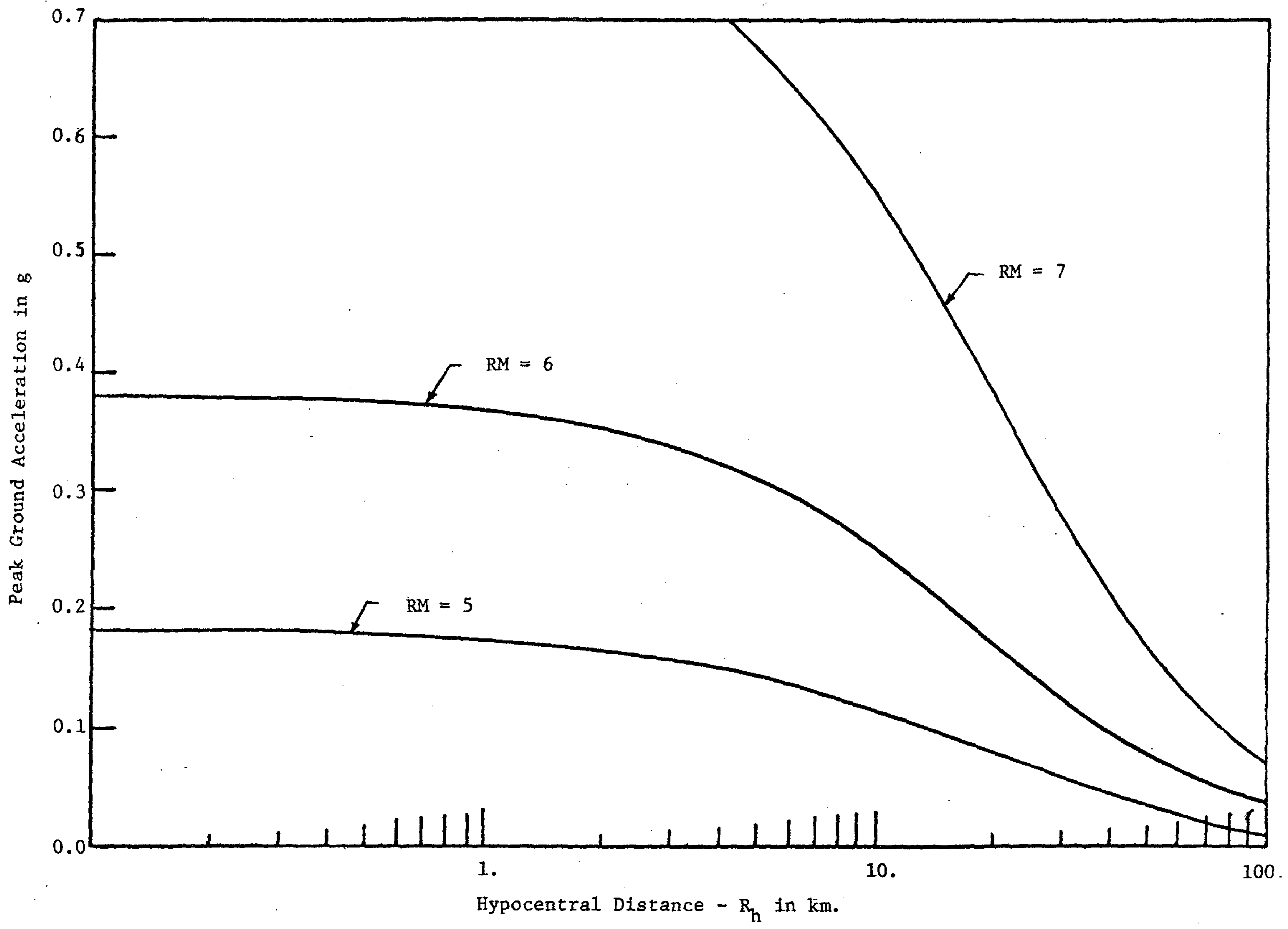


FIGURE A-1b Esteva's 1973 Attenuation Relationship

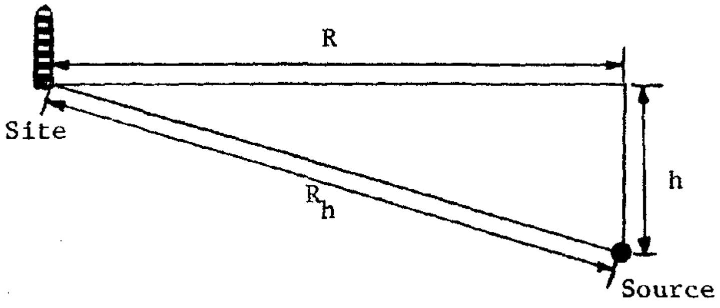
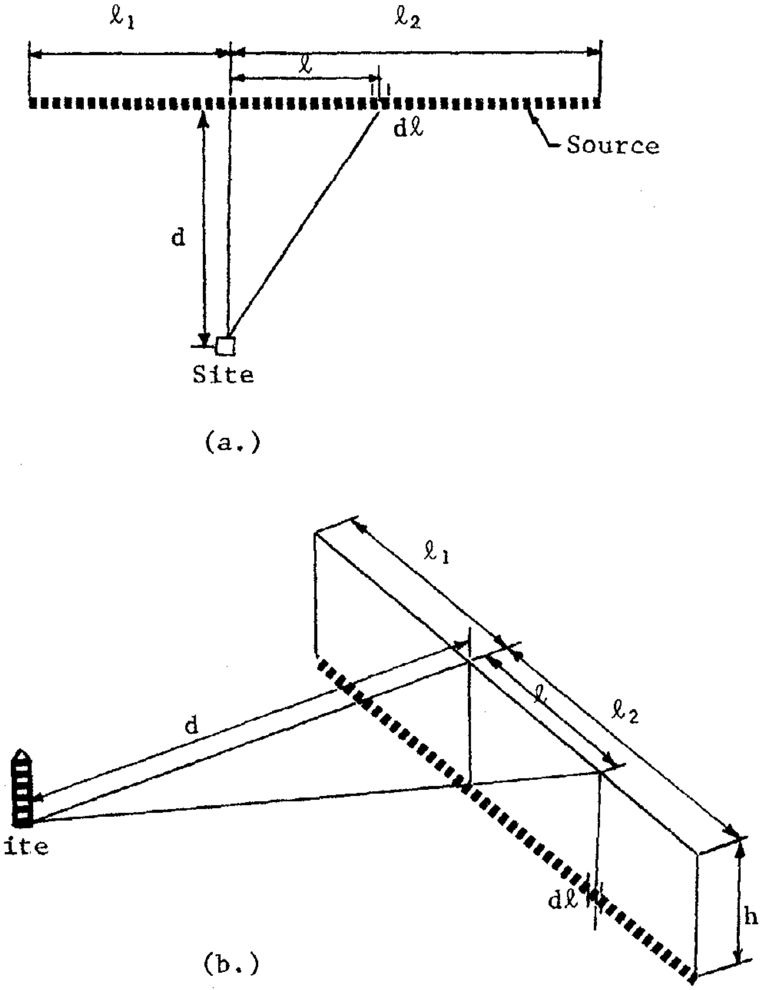


FIGURE A-2 Point Source: Top View



(a.)

(b.)

FIGURE A-3 Line Source: (a.) Top View; (b.) Isometric View

To determine the probability distribution on peak ground acceleration a, the attenuation relationship is used as shown below:

$$P[A > a,t] = P\left[\frac{b_1 \exp(b_2 M)}{(R_h + b_4)^{b_3}} > a,t\right]$$

$$= P\left[M > \ell n\left[\frac{a}{b_1}\left[R_h + b_4\right]^{b_3}\right]^{\frac{1}{b_2}},t\right] \qquad \text{A-12}$$

The last expression in Equation A-12 can be recognized as the distribution on magnitude. Thus, Equation A-12 becomes

$$P[A > a,t] = 1 - \exp\left[-e^{\alpha'}\left[\frac{a}{b_1}\right]^{\frac{\beta}{b_2}}\left[R_h + b_4\right]^{\frac{\beta b_3}{b_2}} t\right] \qquad \text{A-13}$$

By denoting

$$\gamma = e^{\alpha'} \qquad \text{A-14}$$

$$\delta = \frac{\beta}{b_2} \qquad \text{A-15}$$

$$\rho = \frac{\beta b_3}{b_2} = \delta b_3 \qquad \text{A-16}$$

one finally obtains

$$P[A > a,t] = 1 - \exp\left[-\gamma\left[\frac{a}{b_1}\right]^{\delta}\left[R_h + b_4\right]^{\rho} t\right] \qquad \text{A-17}$$

Line Source

Most of the earthquake epicenters around the world are generally located along the major fault systems. Thus, the usual case of epicenters falling along a line gives rise to the so-called line source. The line source can be divided into κ small segments of length Δl_i, $1 \leq i \leq \kappa$.

Let E_{ℓ_i} be the event that no earthquake with a Richter magnitude greater than m occurs on the element $\Delta\ell_i$ in time t. Then, from the Poisson condition on spatial independence the following is true:

$$P\left[\sum_{i=1}^{K} E_{\ell_i}\right] = \sum_{i=1}^{K} P\left[E_{\ell_i}\right] \qquad \text{A-18}$$

The probability of having an earthquake of Richter magnitude smaller than or equal to m due to the entire line source is:

$$P[M \leq m,t] = \lim_{\Delta\ell\to 0} \sum_{i=1}^{K} P\left[E_{\ell_i}\right] = \lim_{\Delta\ell\to 0} \exp\left[-\sum_{i=1}^{K} N'(m)\Delta\ell_i \,.\, t\right] =$$

$$= \exp\left[-\int_{\ell_1}^{\ell_2} N'(m)d\ell \cdot t\right] \qquad \text{A-19}$$

where $\Delta\ell = \max\limits_{1\leq i\leq K} \Delta\ell_i$

The log-linear recurrence relationship is recalled to be

$$\ell n\ N'(m) = \alpha' + \beta M$$

where $N'(m)$ and α' are normalized with respect to the length of the line source and the time period of the data. Substituting for $N'(m)$ into Equation A-19 one gets:

$$P[M \leq m,t] = \exp\left[-\int_{\ell_1}^{\ell_2} \exp\,[\alpha' + \beta m]d\ell \,.\, t\right] \qquad \text{A-20}$$

To obtain the probability of having a maximum peak ground acceleration a, the attenuation relationship (Equation A-9) is used as follows:

$$P[A \leq a,t] = P\left[\frac{b_1 \exp(b_2 M)}{[R_h + b_4]^{b_3}} \leq a,t\right] = P\left[M \leq \ell n \left[\frac{a}{b_1}\right]^{\frac{1}{b_2}} \left[R_h + b_4\right]^{\frac{b_3}{b_2}}, t\right]$$

$$= \exp\left[-e^{\alpha'}\left[\frac{a}{b_1}\right]^{\frac{\beta}{b_1}} \int_{\ell_1}^{\ell_2} [R_h + b_4]^{\frac{\beta b_3}{b_2}} d\ell \cdot t\right] \qquad \text{A-21}$$

Letting $e^{\alpha'}$, $\frac{\beta}{b_1}$ and $\frac{\beta b_3}{b_2}$ be denoted by γ, δ and ρ, respectively, and noting from the geometry of the line source (Figure A-3) that

$$R_h = [d^2 + \ell^2 + h^2]^{1/2} \qquad \text{A-22}$$

one can write:

$$P[A \leq a,t] = \exp\left[-\gamma\left[\frac{a}{b_1}\right]^{\delta} t \int_{\ell_1}^{\ell_2} \left[[d^2 + \ell^2 + h^2]^{1/2} + b_4\right]^{\delta} d\ell\right] \qquad \text{A-24}$$

Alternatively,

$$P[A > a,t] = 1 - \exp\left[-\gamma\left[\frac{a}{b_1}\right]^{\delta} t \int_{\ell_1}^{\ell_2} \left[\left[d^2 + \ell^2 + h^2\right]^{1/2} + b_4\right]^{\delta} d\ell\right] \qquad \text{A-25}$$

Area Source

The peak ground acceleration cumulative distribution function due to an area source at a site can be obtained in a manner similar to that for the line source. Figure A-4 shows schematically the geometry of the area source. Consider an elemental area $\Delta A_i = R_i \Delta R_i \Delta\theta_i$. Let E_{A_i} be the event that no earthquake occurring on the element ΔA_i will have a Richter magnitude larger than m in time t. Then, again from the Poisson condition on spatial independence it follows:

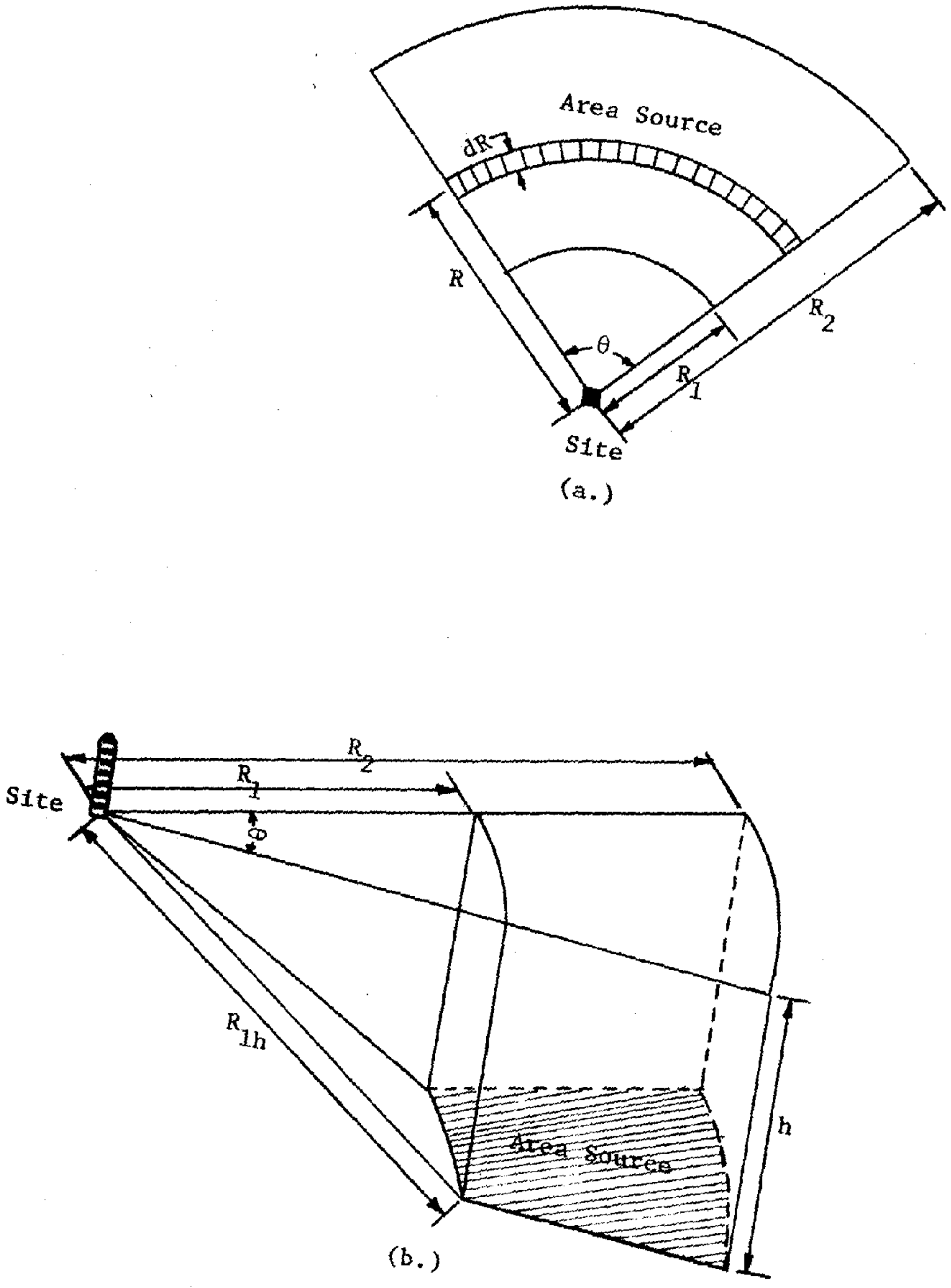


FIGURE A-4 Area Source: (a.) Top View; (b.) Isometric View

$$P\left[\sum_{i=1}^{K} E_{A_i}\right] = \sum_{i=1}^{K} P[E_{A_i}] \qquad \text{A-26}$$

As $\Delta A \to 0$, ΔR and $\Delta\theta$ both approach 0. The probability of having an earthquake of Richter magnitude smaller than or equal to m due to the entire area source is then:

$$P[M \leq m,t] = \lim_{\Delta A \to 0} \sum_{i=1}^{K} P[E_{A_i}] = \lim_{\Delta A \to 0} \exp\left[-\sum_{i=1}^{K} N'(m)\Delta A_i t\right]$$

$$= \exp\left[-\int_0^{\theta}\int_{R_1}^{R_2} N'(m)RdRd\theta \cdot t\right] \qquad \text{A-27}$$

Where N'(m) is the mean rate of occurrence for the area source as defined by Equation 3-3a.

Substituting for n'(m) in Equation A-27 above

$$P[M \leq m,t] = \exp\left[-\int_0^{\theta}\int_{R_1}^{R_2} \exp(\alpha' + \beta m)RdRd\theta \cdot t\right] \qquad \text{A-28}$$

Using the attenuation relationship of Equation A-9

$$P[A \leq a,t] = P\left[\frac{b_1\exp(b_2M)}{(R_h + b_4)^{b_3}} \leq a,t\right]$$

$$= P\left[M \leq \ell n \left[\frac{a}{b_1}\right]^{\frac{1}{b_2}} \left[R_h + b_4\right]^{\frac{b_3}{b_2}} , t\right] \qquad \text{A-29}$$

This equation is of the same form as the equation for the distribution on Richter magnitude (see Equation A-8) and thus can be written as:

$$P[A \leq a,t] = \exp\left[-e^{\alpha'} \left[\frac{a}{b_1}\right]^{\frac{\beta}{b_2}} t \int_0^{\theta} d\theta \int_{R_1}^{R_2} \left[R^2 + h^2 + b_4\right]^{\frac{\beta b_3}{b_2}} RdR \right]$$

$$= \exp\left[-e^{\alpha'} \left[\frac{a}{b_1}\right]^{\frac{\beta}{b_2}} t\theta \int_{R_1}^{R_2} \left[R^2 + h^2 + b_4\right]^{\frac{\beta b_3}{b_2}} RdR \right] \qquad \text{A-30}$$

Let $\gamma = e^{\alpha'}$

$\delta = \beta/b_2$

$\rho = \beta b_3/b_2$ as before

and

$$R_h = \sqrt{R^2 + h^2} \qquad \text{A-31}$$

Then

$$P[A \leq a,t] = \exp\left[-\gamma \left[\frac{a}{b_1}\right]^{\delta} t\theta \int_{R_1}^{R_2} (R_h + b_4)^{\rho} RdR \right] \qquad \text{A-32}$$

and

$$P[A > a,t] = 1 - \exp\left[-\gamma \left[\frac{a}{b_1}\right]^{\delta} t\theta \int_{R_1}^{R_2} (R_h + b_4)^{\rho} RdR \right] \qquad \text{A-33}$$

In general, a site may be surrounded by any or all three types of sources discussed in this section. If there are

NP point sources

NL line sources

NA area sources

the cumulative distribution function of peak ground acceleration at a site is then given by:

$$P[A > a,t] = 1 - \exp\left[- \sum_{i=1}^{NP} \gamma_i \left[\frac{a}{b_1}\right]^{\delta_i} t[R_{h_i} + b_4]^{\rho_i} \right.$$

$$- \sum_{j=1}^{NL} \gamma_j \left[\frac{a}{b_1}\right]^{\delta_i} t \int_{\ell_{1j}}^{\ell_{2j}} \left[\left[d_j^2 + \ell^2 + h_j^2\right]^{1/2} + b_4 \right]^{\rho_i} d\ell$$

$$\left. - \sum_{k=1}^{NA} \gamma_k \left[\frac{a}{b_1}\right]^{\delta_k} t\theta_k \int_{R_{1k}}^{R_{2k}} [R_{h_k} + b_4]^{\rho_k} RdR \right] \qquad \text{A-34}$$

In Equation A-34, the summation over i is for all point sources, that over j is for all line sources, and over k is for all area sources.

As it was shown in Chapter III, eighteen line sources were formulated for the Guatemalan region, based on past data. Any part of the country is affected by these sources, depending upon the proximity of the site to the source location.

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APPENDIX B

BAYESIAN HAZARD MODEL

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B-1 Introduction

Bayesian probabilistic approach has the distinct advantage that it can include subjective information acquired through experience together with the quantitative data. As an alternative to the Poisson modeling presented in Appendix A, a Bayesian model will be used to develop hazard maps in terms of peak ground acceleration and duration of future earthquakes. The method for obtaining these maps will be only reviewed in the present appendix. Its detailed development is given in Mortgat (1976).

B-2 Procedure

The procedure for estimating seismic risk for peak ground accelerations in essence consists of the following steps:

STEP 1. Identification of Earthquake Sources

Based on the geology and historic seismicity of the area sources are identified as point sources, line sources (faults) or area sources. The maximum earthquakes associated with each source are established from historic seismicity and geology (in terms of magnitude or intensity). Typical examples of this approach are Cornell and Vanmarcke (1969), Kiremidjian (1975), Wiggins (1975), Shah et al. (1975), Algermissen (1969).

STEP 2. Selection of Attenuation Relationship

Using one of the numerous empirical attenuation relationships, the peak accelerations at a given site due to earthquakes of various sizes occurring at different locations are estimated. The attenuation relationship is based on data of non-uniform

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quality. Most procedures utilize only the mean curves determined from a regression analysis.

STEP 3. Recurrence of Earthquakes

The recurrence of earthquakes of various sizes is estimated based primarily on the historic seismicity. A straight line or a set of straight lines is fitted on the data using regression analysis. This method usually results in unacceptable uncertainties for large magnitudes where the data is scarce. Some variations have been proposed. For example Wiggins (1975) uses a Bayesian procedure at the level of the results once the analysis is complete.

STEP 4. Results

Utilizing the computations in Steps (1), (2) and (3) the probability that a certain acceleration will not be exceeded within a given time period t is determined. The results of the evaluation are presented in terms of iso-acceleration or iso-intensity curves for selected levels of probability and time periods.

B-3 Seismic Mapping Model

The following paragraphs present the general model used for seismic mapping in the current study.

Source Location

The location of the sources is made using the recorded hypocentral position of past earthquakes for the period of the records. The spatial distribution of hypocenters is then divided in different sources as a function of their shapes and seismicity (defined as the number of occurrences per unit area or unit length).

Seismic Model

In the data presently available, the most commonly used measure of energy release is the Richter magnitude. In this model, the seismicity of the sources is described by the distribution on the number of occurrences for each magnitude. This is different from the current practice where the source seismicity is described by the probability of generating an event larger than a given magnitude and not by a distribution on all the events.

Occurrences: Assuming that earthquake occurrences form a Poisson process with mean rate of occurrence independent of magnitude, a distribution is obtained on the number of occurrences for a given period of time for a given source. The assumption of spatial and temporal independence is fairly well verified by data and is a common accepted practice in seismology. Moreover the amount of dependence due to the dual mechanism of stress accumulation and release has not been determined as yet.

Magnitude: Given that an event has occurred, a distribution on the magnitude is determied from past data. The magnitudes are discretized every 1/4 point as it is commonly done in data recording. This representation has the advantage of getting away from the data fitting. This method is specially valuable for regions where little data is available. The probability corresponding to each magnitude can be used in a Bernoulli trial where one outcome will be an event of the magnitude considered (success) and the other an event of any other magnitude (failure). The following question can then be answered: "Given that N earthquakes will occur, what is the probability that there will be 0, 1, 2, . . . N events of any given magnitude?" Combining those Binomial conditional distributions with the Poisson distribution on occurrences, the distribution on the number of occurrences for each magnitude is obtained.

Bayesian Statistics

Bayesian statistics is applied to the Poisson and Binomial laws to eliminate some of the incompleteness of the data. For example, considering the fault length and the type of fault, geologists can determine the maximum magnitude earthquake the source can generate. This information has to be taken into consideration even if no such earthquake has been recorded in the data. This is done by assuming the mean rate of occurrences of the Poisson law to be a Gamma probability distribution (Benjamin and Cornell, 1970) and the probability of success of the Binomial law to be a Beta probability distribution (Benjamin and Cornell, 1970). This method has the advantage of including personal experience together with the data as well as updating the distribution as new data is made available.

Mapping Parameters

Two mapping parameters are used, namely the PGA and the duration of the ground motion. PGA was used since no other attenuation relationship is readily available in the literature. The methodology allows for the use of a more stable parameter such as rms that would certainly improve the reliability of the model.

Attenuation Relationship

The Esteva (1973) relationship is used to relate PGA to magnitude as a function of distance. Attenuation on duration is obtained using the relation developed by Bolt (1973).

Both relationships are treated probabilistically to take into consideration uncertainty in the attenuation decay.

Combining the distributions that describe the seismicity at the sources with the two transfer functions, the probability of exceedance of any PGA or duration is obtained at the site.

TABLE B-1

Duration Attenuation

M distance	5.5	6.0	6.5	7.0	7.5	8.0	8.5
10	8	12	19	26	31	34	35
25	4	9	15	24	28	30	32
50	2	3	10	22	26	28	29
75	1	1	5	10	14	16	17
100	0	0	1	4	5	6	7
125	0	0	1	2	2	3	3
150	0	0	0	1	2	2	3
175	0	0	0	0	1	2	2
200	0	0	0	0	0	1	2

B-4 Guatemala Bayesian Acceleration and Duration Maps

The Bayesian forecast model discussed in the previous section is applied to Guatemala. The data base and the eighteen seismic sources described in Chapter III are used directly in this model. For each source the following information is gathered:

(1) The number of recorded earthquakes N for discretized intervals of Richter magnitude M. An increment of 0.25M is used for the discretization.

(2) The time period of the data T.

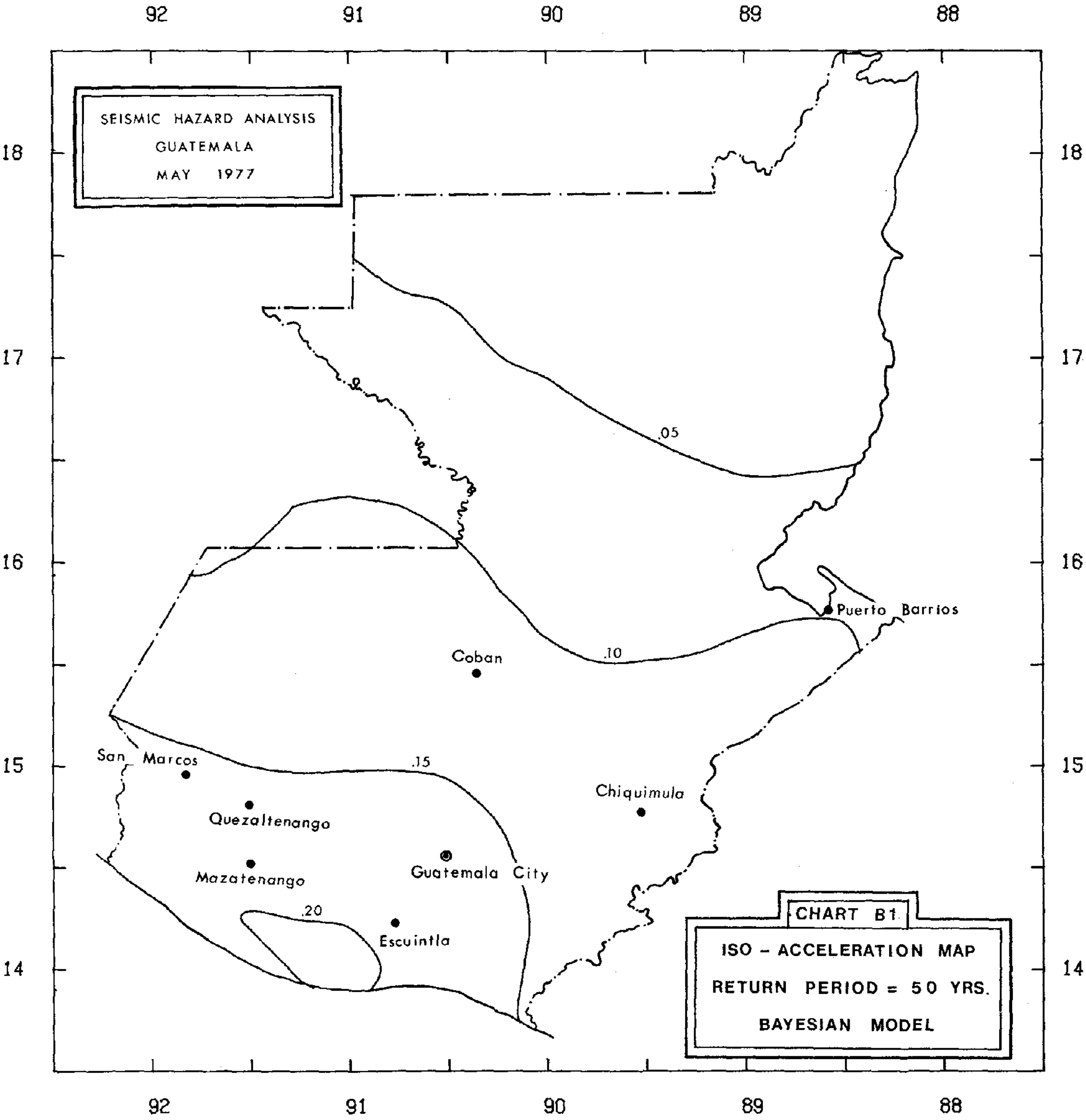
(3) The value of the parameters λ' and ν' of the Gamma distribution (Benjamin and Cornell, 1970) determined from subjective input.

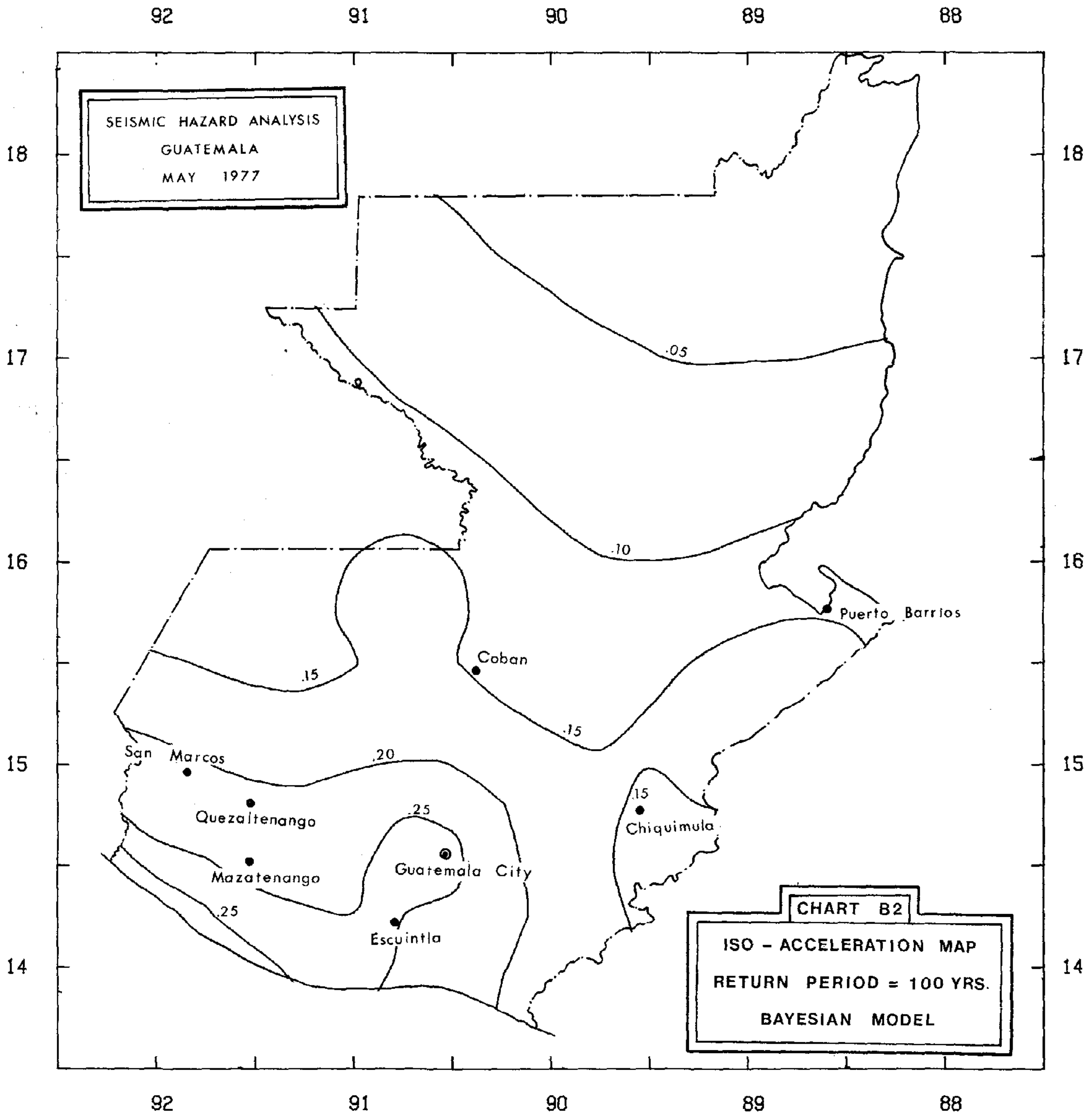
(4) The values of the parameters η'_{M_i} and ξ'_{M_i} of the Beta distribution (Benjamin and Cornell, 1970) which also come from subjective input.

The values of all of these parameters are determined for each source and are listed in Tables B2 - B19. This procedure developed by Mortgat (1976) has a uniform distribution associated with the peak ground acceleration attenuation relationship (Equation 4-1). The coefficient of variation for this distribution is assumed to be 0.30.

For the duration maps, Table B1 lists the relationship between the Richter magnitude, distance from the source to the site and the duration (from Bolt, 1973). A coefficient of variation of 0.30 is also applied to these duration values.

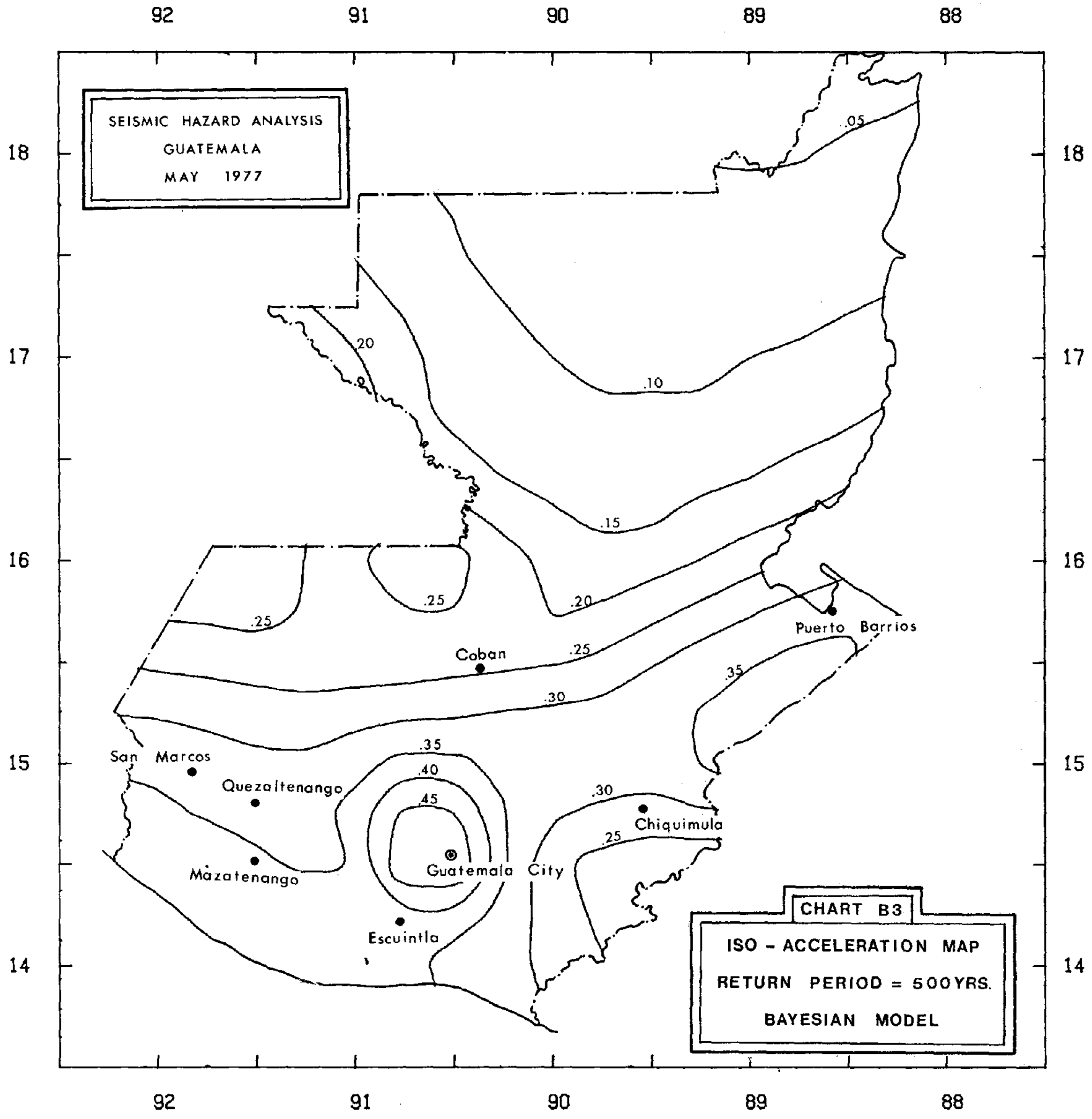
Charts B1 to B4 show the resulting iso-acceleration maps for return periods of 50, 100, 500 and 1000 years. The iso-duration maps for the same return periods are represented in Charts B5 to B8. A low seismicity region in the northern part of Guatemala can be observed in all maps both for duration and acceleration. The high regions in the south-southwest portion and along the Cayman trough is also common to all maps.

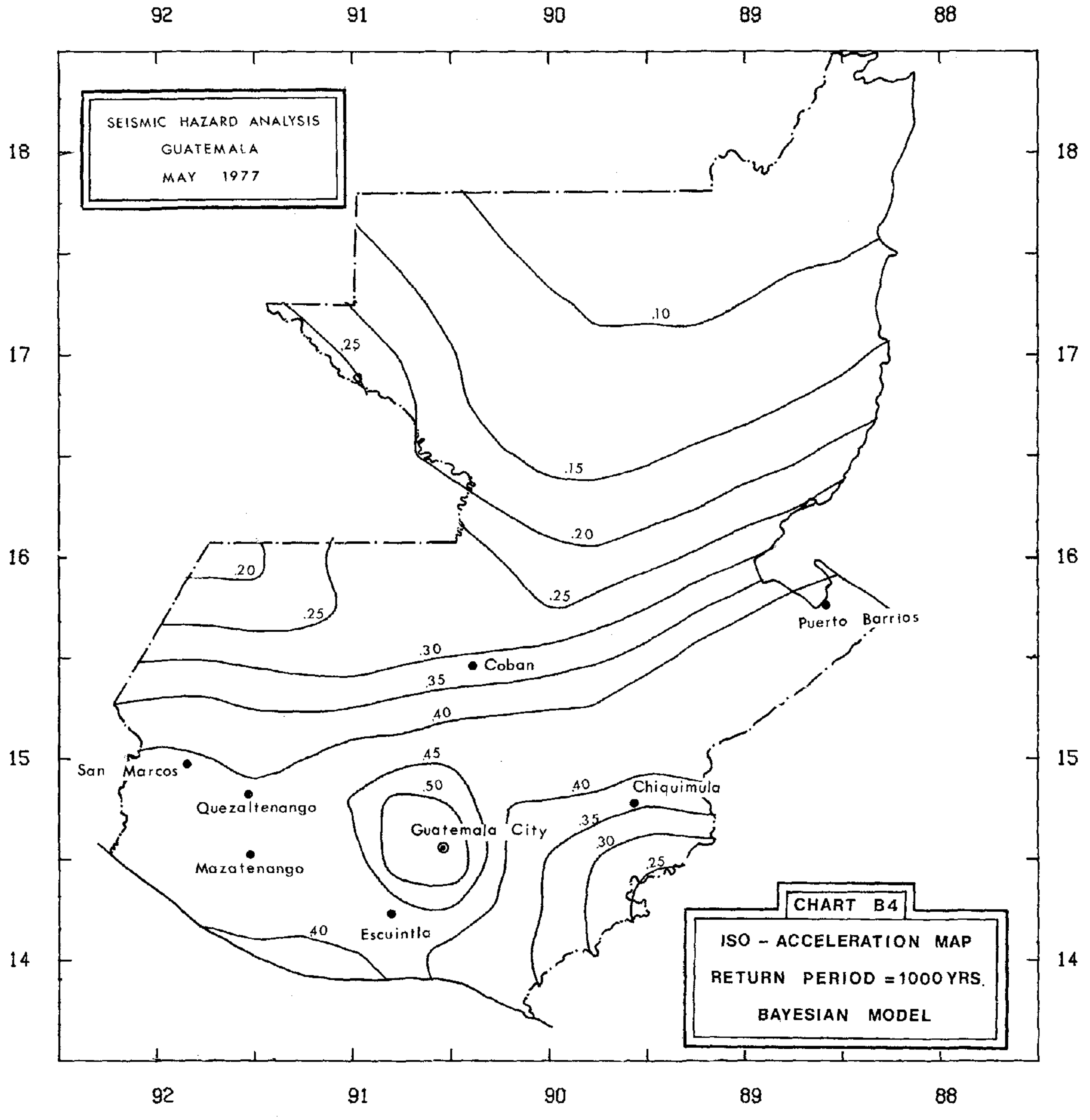

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART B1
ISO - ACCELERATION MAP
RETURN PERIOD = 50 YRS.
BAYESIAN MODEL
92
91
90
89
88
18
17
16
15
14
.05
.10
.15
.20
Puerto Barrios
Coban
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Chiquimula
Escuintla

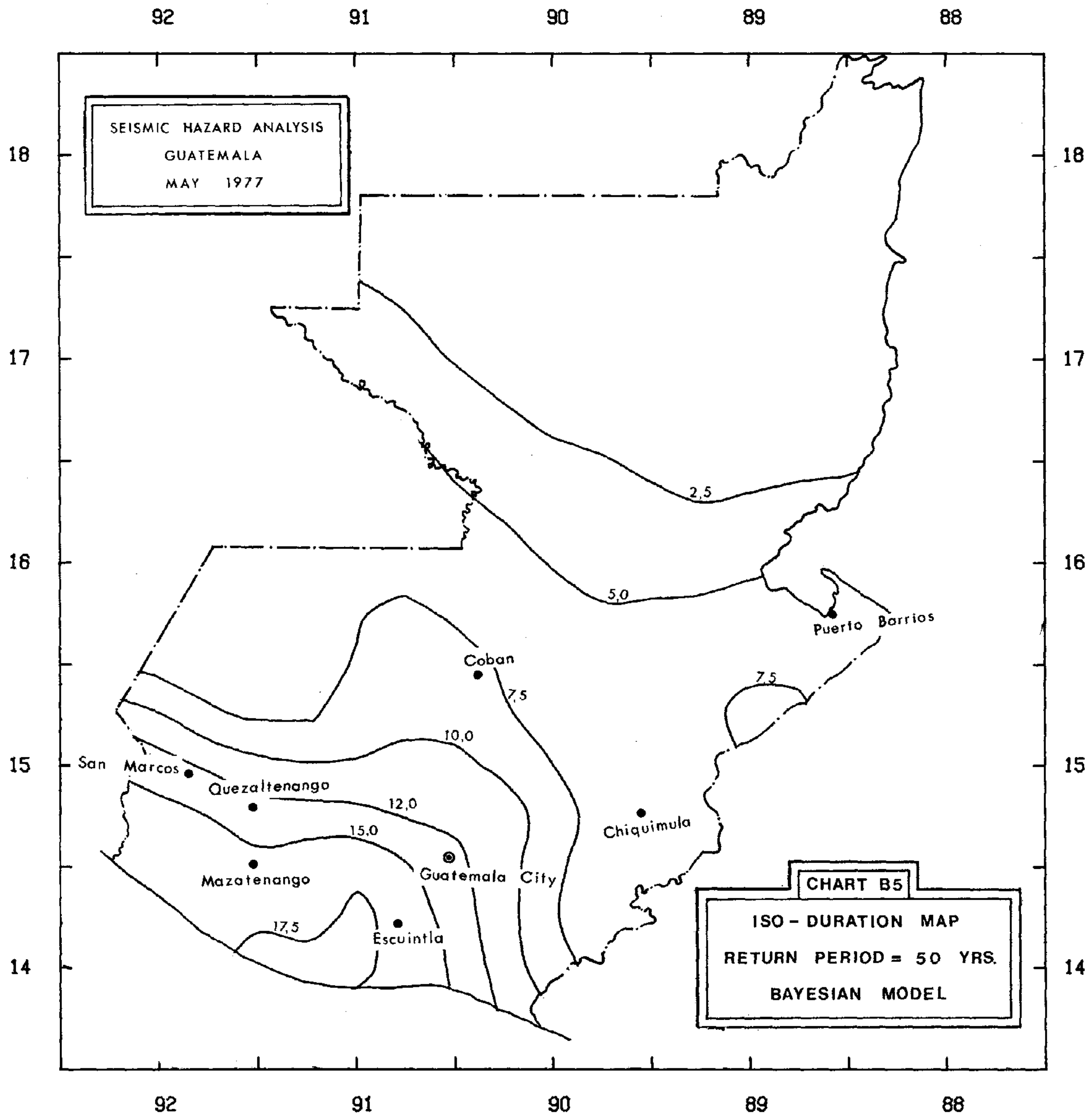


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

CHART B2
ISO - ACCELERATION MAP
RETURN PERIOD = 100 YRS.
BAYESIAN MODEL


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART B3
ISO - ACCELERATION MAP
RETURN PERIOD = 500YRS.
BAYESIAN MODEL
92
91
90
89
88
18
17
16
15
14
.05
.10
.15
.20
.25
.30
.35
.40
.45
Coban
Puerto Barrios
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Escuintla
Chiquimula


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART B4
ISO - ACCELERATION MAP
RETURN PERIOD = 1000 YRS.
BAYESIAN MODEL
92
91
90
89
88
18
17
16
15
14
.10
.15
.20
.25
.30
.35
.40
.45
.50
Coban
Puerto Barrios
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Escuintla
Chiquimula



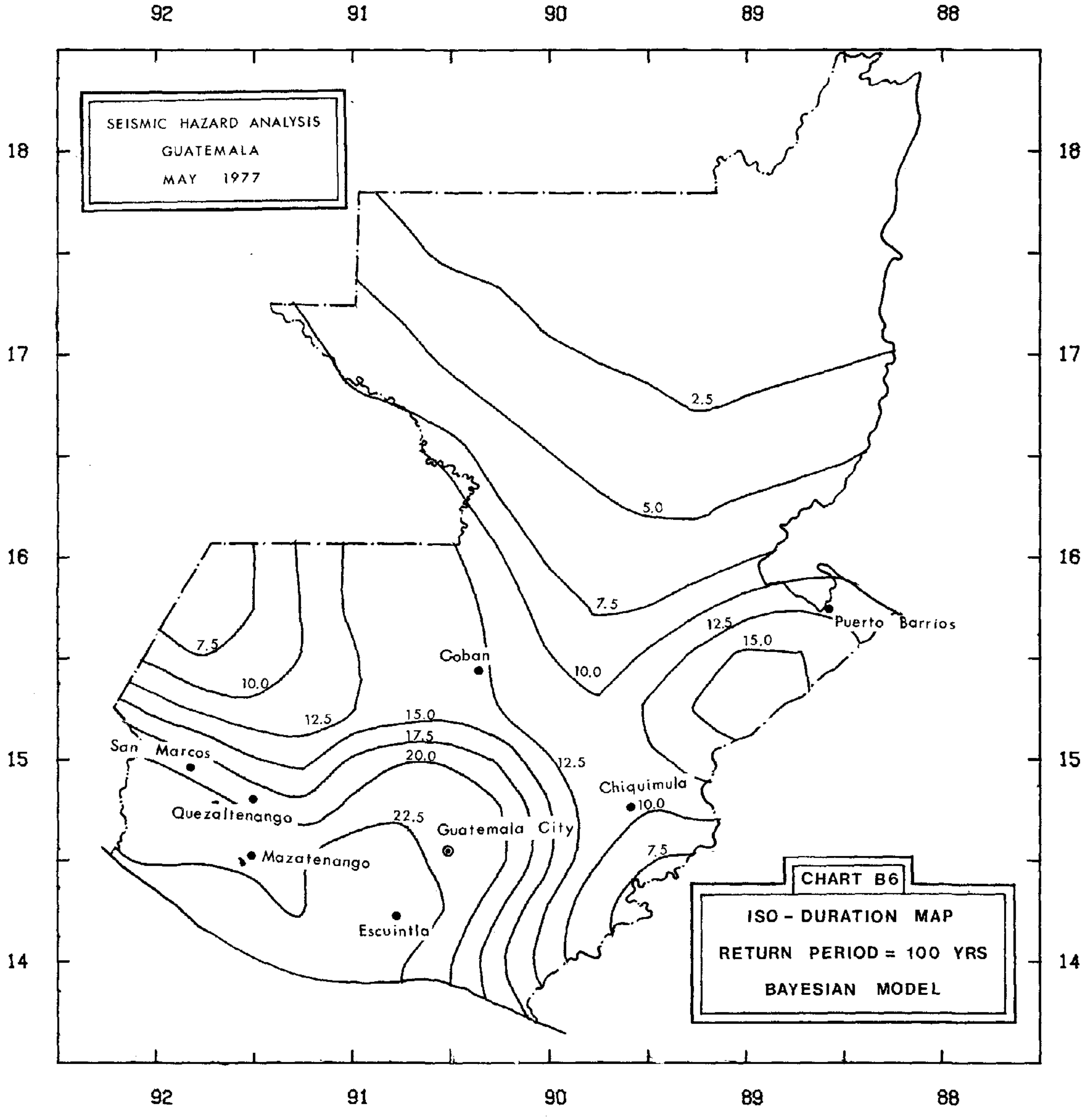
SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

CHART B5

ISO - DURATION MAP

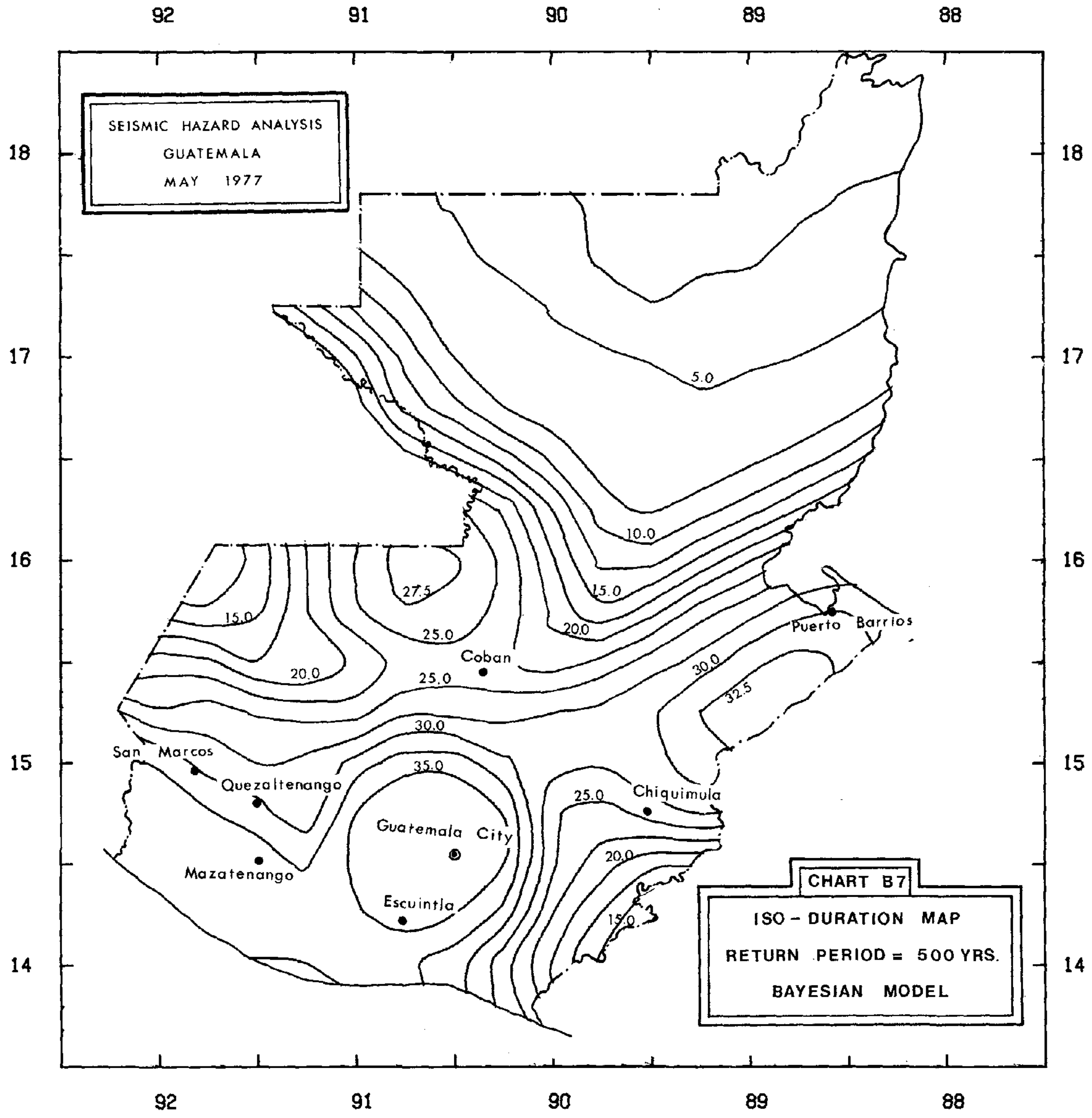
RETURN PERIOD = 50 YRS.

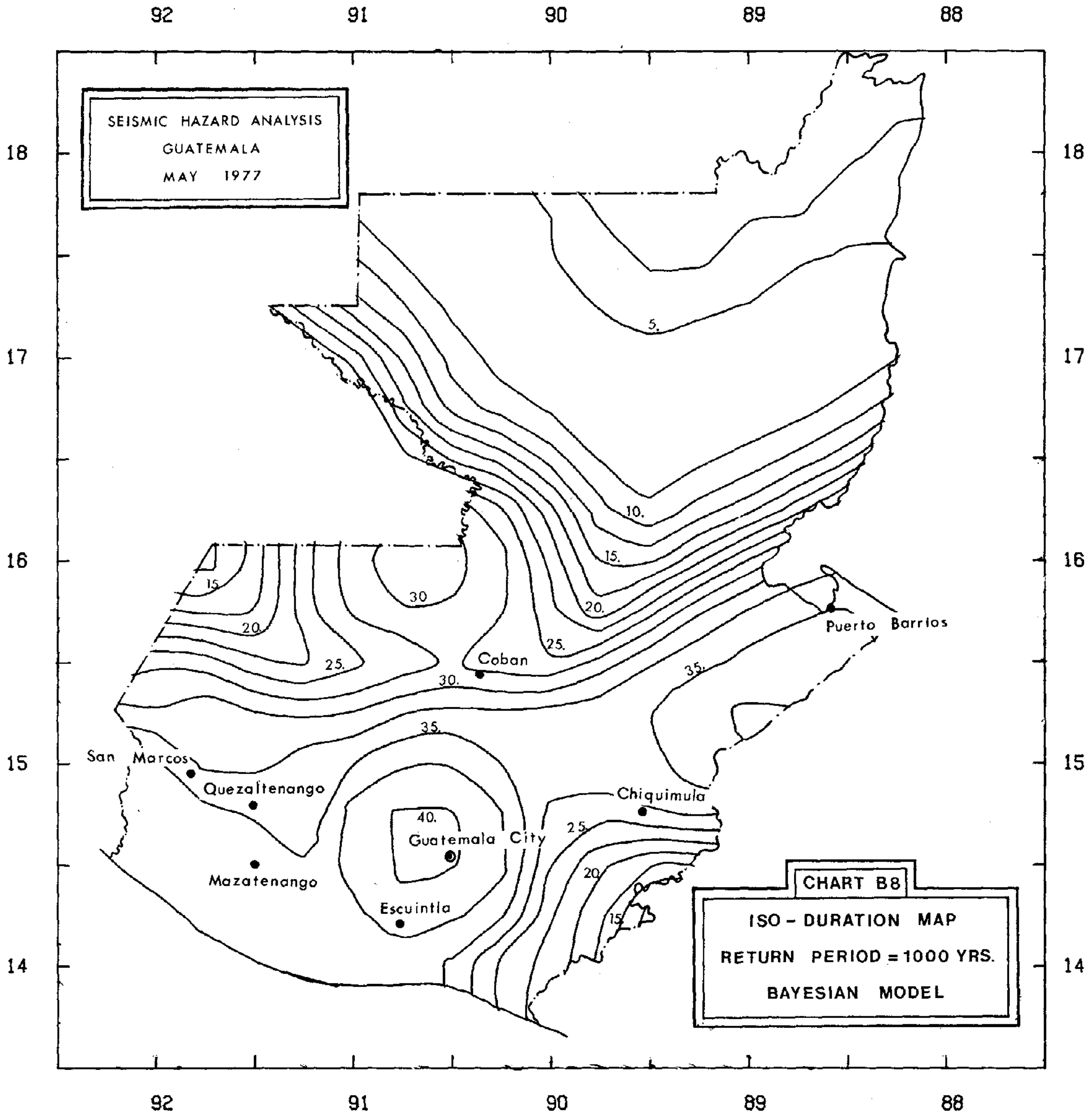
BAYESIAN MODEL



SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

CHART B6
ISO - DURATION MAP
RETURN PERIOD = 100 YRS
BAYESIAN MODEL


SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
CHART B7
ISO - DURATION MAP
RETURN PERIOD = 500 YRS.
BAYESIAN MODEL
92
91
90
89
88
18
17
16
15
14
5.0
10.0
15.0
20.0
25.0
27.5
30.0
32.5
35.0
Coban
Puerto Barrios
San Marcos
Quezaltenango
Mazatenango
Guatemala City
Escuintla
Chiquimula



SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

CHART B8

ISO - DURATION MAP
RETURN PERIOD = 1000 YRS.
BAYESIAN MODEL

Comparing the iso-acceleration maps from the Bayesian model to the iso-acceleration maps from the original Poisson model (Charts 7 to 10), the acceleration values are higher for the maps in Charts B1 to B4. Also, in Charts 7 to 10 the effect of some of the faults (e.g., Mixco, Motagua, Polochic) has been accentuated while the effect of some others (e.g., Jocotan) has been reduced. Overall however, the maps appear quite similar. It should be pointed out that the advantages of the Bayesian approach are:

(1) subjective information can be included

(2) it is easier to incorporate additional earthquake data.

In a manner similar to Charts 7 to 10, the iso-acceleration and iso-duration maps resulting from the Bayesian approach can be used for zoning pruposes. Again, their application for design and analysis of structures in Guatemala will be discussed at length in the Part II report of the present study.

TABLE B2

Bayesian Data Information

Source 1

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 12
ν' from log-linear fit : 14.14
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 14.14 + 12 = 26.14$
$\eta''_{M_i} = \eta'_{M_i} + N = 14.14 + 12 = 26.14$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	2	14.14	2.55	4.55
4.25	1	11.59	2.09	3.09
4.50	2	9.50	1.71	3.71
4.75	0	7.79	1.41	1.41
5.00	2	6.38	1.15	3.15
5.25	0	5.23	0.94	0.94
5.50	2	4.29	0.78	2.78
5.75	1	3.51	0.63	1.63
6.00	0	2.88	0.52	0.52
6.25	0	2.36	0.42	0.42
6.50	1	1.94	0.35	1.35
6.75	0	1.59	0.29	0.29
7.00	0	1.30	0.24	0.24
7.25	0	1.06	0.19	0.19
7.50	1	0.87	0.15	1.15
7.75	0	0.72	0.13	0.13
8.00	0	0.59	0.11	0.11
8.25	0	0.48	0.09	0.09
8.50	0	0.39	0.39	0.39

TABLE B3

Bayesian Data Information

Source 2

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 6
ν' from log-linear fit : 7.09
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 7.09 + 6 = 13.09$
$\eta''_{M_i} = \eta'_{M_i} + N = 7.09 + 6 = 13.09$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	7.09	1.28	2.28
4.25	0	5.81	1.05	1.05
4.50	1	4.76	0.86	1.86
4.75	0	3.90	0.70	0.70
5.00	1	3.20	0.58	1.58
5.25	0	2.62	0.47	0.47
5.50	2	2.15	0.39	2.39
5.75	0	1.76	0.32	0.32
6.00	1	1.44	0.26	1.26
6.25	0	1.18	0.21	0.21
6.50	0	0.97	0.18	0.18
6.75	0	0.79	0.14	0.14
7.00	0	0.65	0.12	0.12
7.25	0	0.53	0.09	0.09
7.50	0	0.44	0.08	0.08
7.75	0	0.36	0.07	0.07
8.00	0	0.29	0.29	0.29

TABLE B4

Bayesian Data Information

Source 3

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 9
ν' from log-linear fit : 8.89
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 8.89 + 9 = 17.89$
$\eta''_{M_i} = \eta'_{M_i} + N = 8.89 + 9 = 17.89$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	8.89	1.47	2.47
4.25	1	7.42	1.22	2.22
4.50	2	6.20	1.02	3.02
4.75	0	5.18	0.86	0.86
5.00	2	4.32	0.71	2.71
5.25	0	3.61	0.60	0.60
5.50	0	3.01	0.55	0.55
5.75	0	2.52	0.42	0.42
6.00	1	2.10	0.34	1.34
6.25	1	1.76	0.29	1.29
6.50	0	1.47	0.22	0.22
6.75	1	1.22	0.20	1.20
7.00	0	1.02	0.17	0.17
7.25	0	0.85	0.14	0.14
7.50	0	0.71	0.11	0.11
7.75	0	0.60	0.10	0.10
8.00	0	0.50	0.50	0.50

TABLE B5

Bayesian Data Information

Source 4

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 17
ν' from log-linear fit : 21.53
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 21.53 + 17 = 38.53$
$\eta''_{M_i} = \eta'_{M_i} + N = 21.53 + 17 = 38.53$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	2	21.53	2.80	4.80
4.25	1	18.73	2.44	3.44
4.50	2	16.29	2.12	5.12
4.75	0	14.17	1.85	1.85
5.00	2	12.32	1.50	3.50
5.25	0	10.82	1.50	1.50
5.50	1	9.32	1.21	2.21
5.75	0	8.11	1.06	1.06
6.00	2	7.05	0.91	2.91
6.25	1	6.14	0.92	1.92
6.50	3	5.22	2.18	5.18
6.75	1	3.04	1.27	2.27
7.00	1	1.77	0.74	1.74
7.25	1	1.03	0.43	1.43
7.50	0	0.60	0.25	0.25
7.75	0	0.35	0.15	0.15
8.00	0	0.20	0.20	0.20

TABLE B6

Bayesian Data Information

Source 5

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 5
ν' from log-linear fit : 5.52
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 5.53 + 5 = 10.53$
$\eta''_{M_i} = \eta'_{M_i} + N = 5.53 + 5 = 10.53$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	5.53	1.57	2.57
4.25	1	3.96	1.14	2.14
4.50	0	2.82	0.80	0.80
4.75	2	2.02	0.58	2.58
5.00	1	1.44	0.41	1.41
5.25	0	1.03	0.29	0.29
5.50	0	0.74	0.21	0.21
5.75	0	0.53	0.15	0.15
6.00	0	0.38	0.38	0.38

TABLE B7

Bayesian Data Information

Source 6

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 3
ν' from log-linear fit : 2.74
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 2.74 + 3 = 5.74$
$\eta''_{M_i} = \eta'_{M_i} + N = 2.74 + 3 = 5.75$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	2.74	0.41	1.41
4.25	1	2.33	0.34	1.34
4.50	0	1.99	0.30	0.30
4.75	0	1.69	0.25	0.25
5.00	0	1.44	0.22	0.22
5.25	0	1.22	0.18	0.18
5.50	0	1.04	0.15	0.15
5.75	1	0.89	0.14	1.14
6.00	0	0.75	0.11	0.11
6.25	0	0.64	0.10	0.10
6.50	0	0.54	0.54	0.54

TABLE B8

Bayesian Data Information

Source 7

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 5
ν' from log-linear fit : 4.22
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 4.22 + 5 = 9.22$
$\eta''_{M_i} = \eta'_{M_i} + N = 4.22 + 5 = 9.22$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	4.22	0.62	1.62
4.25	1	3.60	0.53	1.53
4.50	1	3.07	0.45	1.45
4.75	0	2.62	0.39	0.39
5.00	1	2.23	0.32	1.32
5.25	0	1.91	0.28	0.28
5.50	0	1.63	0.24	0.24
5.75	0	1.39	0.21	0.21
6.00	0	1.18	0.17	0.17
6.25	0	1.01	0.15	0.15
6.50	1	0.86	0.13	0.13
6.75	0	0.73	0.10	1.10
7.00	0	0.63	0.63	0.63

TABLE B9

Bayesian Data Information

Source 8

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 6
ν' from log-linear fit : 7.22
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 7.22 + 6 = 13.22$
$\eta''_{M_i} = \eta'_{M_i} + N = 7.22 + 6 = 13.22$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	1	7.22	1.00	2.00
4.25	0	6.22	0.85	0.85
4.50	1	5.37	0.75	1.75
4.75	0	4.62	0.63	0.63
5.00	1	3.99	0.55	1.55
5.25	0	3.44	0.48	0.48
5.50	0	2.96	0.41	0.41
5.75	1	2.55	0.35	1.35
6.00	2	2.20	0.30	2.30
6.25	0	1.90	0.26	0.26
6.50	0	1.64	0.23	0.23
6.75	0	1.41	0.19	0.19
7.00	0	1.22	0.17	0.17
7.25	0	1.05	0.15	0.15
7.50	0	0.90	0.90	0.9

TABLE B10

Bayesian Data Information

Source 9

Time Data Base (T) : 75 years
Number of Recorded Events (N): 9
ν' from log-linear fit : 9.29
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 9.29 + 9 = 18.29$
$\eta''_{M_i} = \eta'_{M_i} + N = 9.29 + 9 = 18.29$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	2	9.29	1.04	3.04
4.25	1	8.25	0.93	1.93
4.50	0	7.32	0.82	0.82
4.75	0	6.50	0.72	0.72
5.00	0	5.78	0.65	0.65
5.25	1	5.13	0.72	1.72
5.50	2	4.41	0.82	2.82
5.75	0	3.59	0.67	0.67
6.00	1	2.92	0.55	1.55
6.25	1	2.38	0.45	1.45
6.50	0	1.93	0.35	0.35
6.75	0	1.57	0.29	0.29
7.00	0	1.28	0.24	0.24
7.25	0	1.04	0.19	0.19
7.50	1	0.85	0.16	1.16
7.75	0	0.69	0.13	0.13
8.00	0	0.56	0.56	0.56

TABLE B11

Bayesian Data Information

Source 10

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 7
ν' from log-linear fit : 7.58
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 7.58 + 7 = 14.58$
$\eta''_{M_i} = \eta'_{M_i} + N = 7.58 + 7 = 14.58$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	0	7.58	0.65	0.65
4.25	1	6.93	0.60	1.60
4.50	0	6.33	0.54	0.54
4.75	1	5.79	0.50	1.50
5.00	1	5.29	0.45	1.45
5.25	0	4.84	0.82	0.42
5.50	0	4.42	1.13	1.13
5.75	2	3.29	1.08	3.08
6.00	0	2.21	0.72	0.72
6.25	1	1.49	0.49	1.49
6.50	1	1.00	0.33	1.33
6.75	0	0.67	0.22	0.22
7.00	0	0.45	0.15	0.15
7.25	0	0.30	0.10	0.10
7.50	0	0.20	0.20	0.20

TABLE B12

Bayesian Data Information

Source 11

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 5
ν' from log-linear fit : 4.43
$\lambda'' = \lambda' + T = 75 + 75$
$\nu'' = \nu' + N = 4.43 + 5 = 9.43$
$\eta''_{M_i} = \eta'_{M_i} + N = 4.43 + 5 = 9.43$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	3	4.43	0.56	3.56
4.25	0	3.87	0.49	0.49
4.50	0	3.38	0.42	0.42
4.75	0	2.96	0.38	0.38
5.00	0	2.58	0.32	0.32
5.25	0	2.26	0.29	0.29
5.50	0	1.97	0.25	0.25
5.75	0	1.72	0.21	0.21
6.00	1	1.51	0.19	1.19
6.25	1	1.32	0.17	1.17
6.50	0	1.15	0.15	0.15
6.75	0	1.00	0.12	0.12
7.00	0	0.88	0.11	0.11
7.25	0	0.77	0.10	0.10
7.50	0	0.67	0.67	0.67

TABLE B13

Bayesian Data Information

Source 12 - Benioff 1

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 122
ν' from log-linear fit : 111.21
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 111.21 + 122 = 233.21$
$\eta''_{M_i} = \eta'_{M_i} + N = 111.21 + 122 = 233.21$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	41	111.21	26.96	67.96
4.25	9	84.25	20.43	29.43
4.50	19	63.82	15.47	34.47
4.75	5	48.35	11.73	16.73
5.00	15	36.62	8.87	23.87
5.25	1	27.75	6.73	7.73
5.50	10	21.02	5.10	15.10
5.75	5	15.92	3.86	8.86
6.00	6	12.06	2.92	8.92
6.25	2	9.14	2.22	4.22
6.50	4	6.92	1.68	5.68
6.75	1	5.24	1.27	2.27
7.00	1	3.97	0.96	1.96
7.25	3	3.01	0.73	3.73
7.50	0	2.28	0.55	0.55
7.75	0	1.73	0.42	0.42
8.00	0	1.31	0.32	0.32
8.25	0	0.99	0.24	0.24
8.50	0	0.75	0.75	0.75

TABLE B14

Bayesian Data Information

Source 13 - Benioff 2

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 45
ν' from log-linear fit : 40.17
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 40.17 + 45 = 85.17$
$\eta''_{M_i} = \eta'_{M_i} + N = 40.17 + 45 = 85.17$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	17	40.17	9.10	26.10
4.25	8	31.07	10.71	18.71
4.50	4	20.36	7.02	11.02
4.75	5	13.34	4.60	9.60
5.00	6	8.74	3.02	9.02
5.25	3	5.72	1.97	4.97
5.50	0	3.75	1.29	1.29
5.75	0	2.46	0.85	0.85
6.00	1	1.61	0.56	1.56
6.25	1	1.05	0.36	1.36
6.50	0	0.69	0.24	0.24
6.75	0	0.45	0.15	0.15
7.00	0	0.30	0.11	0.11
7.25	0	0.19	0.06	0.06
7.50	0	0.13	0.05	0.05
7.75	0	0.08	0.03	0.03
8.00	0	0.05	0.02	0.02
8.25	0	0.03	0.01	0.01
8.50	0	0.02	0.02	0.02

TABLE B15

Bayesian Data Information

Source 14 - Benioff 3

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 93
ν' from log-linear fit : 84.08
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 84.08 + 93 = 177.08$
$\eta''_{M_i} = \eta'_{M_i} + N = 84.08 + 93 = 177.08$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	22	84.08	17.68	39.68
4.25	9	66.40	13.97	22.97
4.50	18	52.43	11.03	29.03
4.75	6	41.40	8.71	14.71
5.00	14	32.69	6.88	20.88
5.25	4	25.81	5.43	9.43
5.50	4	20.38	4.28	8.28
5.75	3	16.10	3.39	6.39
6.00	4	12.71	6.02	10.02
6.25	4	6.69	3.51	7.51
6.50	2	3.18	1.67	3.67
6.75	3	1.51	0.79	3.79
7.00	0	0.72	0.38	0.38
7.25	0	0.34	0.18	0.18
7.50	0	0.16	0.08	0.08
7.75	0	0.08	0.04	0.04
8.00	0	0.04	0.02	0.02
8.25	0	0.02	0.01	0.01
8.50	0	0.01	0.01	0.01

TABLE B16

Bayesian Data Information

Source 15 - Benioff 4

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 130
ν' from log-linear fit : 110.86
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 110.86 + 130 = 240.86$
$\eta''_{M_i} = \eta'_{M_i} + N = 110.86 + 130 = 240.86$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	35	110.86	17.00	52.00
4.25	7	93.86	14.39	21.39
4.50	19	79.47	12.19	31.19
4.75	12	67.28	10.32	22.32
5.00	11	56.96	8.74	19.74
5.25	5	48.22	10.99	15.99
5.50	9	37.23	8.19	17.19
5.75	7	28.04	6.92	13.92
6.00	8	21.12	5.22	13.22
6.25	6	15.90	3.92	9.92
6.50	3	11.98	2.86	5.86
6.75	3	9.02	2.23	5.23
7.00	2	6.79	1.67	3.67
7.25	0	5.12	1.27	1.27
7.50	0	3.85	0.95	0.95
7.75	0	2.90	0.71	0.71
8.00	1	2.19	0.54	1.54
8.25	2	1.65	0.41	2.41
8.50	0	1.24	1.24	1.24

TABLE B17

Bayesian Data Information

Source 16 - Benioff 5

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 63
ν' from log-linear fit : 59.46
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 59.46 + 63 = 122.46$
$\eta''_{M_i} = \eta'_{M_i} + N = 59.46 + 63 = 122.46$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	13	59.46	8.57	21.57
4.25	6	50.89	7.33	13.33
4.50	8	43.56	6.28	14.28
4.75	4	37.28	7.17	11.17
5.00	6	30.11	7.23	13.23
5.25	3	22.88	5.49	8.49
5.50	8	17.39	4.17	12.17
5.75	3	13.22	3.17	6.17
6.00	5	10.05	2.42	7.42
6.25	2	7.63	1.83	3.83
6.50	2	5.80	1.39	3.39
6.75	1	4.41	1.06	2.06
7.00	0	3.35	0.80	0.80
7.25	0	2.55	0.62	0.62
7.50	1	1.93	0.46	1.46
7.75	0	1.47	0.35	0.35
8.00	0	1.12	0.27	0.27
8.25	0	0.85	0.20	0.20
8.50	1	0.65	0.65	1.65

TABLE B18

Bayesian Data Information

Source 17 - Benioff 6

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 19
ν' **from log-linear fit** : 18.32
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 18.32 + 19 = 37.32$
$\eta''_{M_i} = \eta'_{M_i} + N = 18.32 + 19 = 37.32$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	5	18.32	2.86	7.86
4.25	1	15.46	2.42	3.42
4.50	2	13.04	2.03	4.03
4.75	1	11.01	1.72	2.72
5.00	2	9.29	1.46	3.46
5.25	2	7.83	1.22	3.22
5.50	0	6.61	1.65	1.65
5.75	3	4.96	2.14	5.14
6.00	1	2.82	1.21	2.21
6.25	1	1.61	0.69	1.69
6.50	1	0.92	0.40	1.40
6.75	0	0.52	0.22	0.22
7.00	0	0.30	0.13	0.13
7.25	0	0.17	0.07	0.07
7.50	0	0.10	0.05	0.05
7.75	0	0.05	0.02	0.02
8.00	0	0.03	0.01	0.01
8.25	0	0.02	0.01	0.01
8.50	0	0.01	0.01	0.01

TABLE B19

Bayesian Data Information

Source 18 - Benioff 7

Time Data Base (T) : 75 years
Number of Recorded Events (N) : 24
ν' **from log-linear fit** : 20.80
$\lambda'' = \lambda' + T = 75 + 75 = 150$
$\nu'' = \nu' + N = 20.80 + 24 = 44.80$
$\eta''_{M_i} = \eta'_{M_i} + N = 20.80 + 24 = 44.80$

Richter Magnitude (M_i)	Nb of Recorded Occurrences in M_i bands (R_{M_i})	Cumulative Nb of Occurrences (log-linear fit Fig.) (N_c)	Nb of Occurrences in M_i bands (log-linear fit) (ξ'_{M_i})	$\xi'_{M_i} + R_{M_i}$ (ξ''_{M_i})
4.00	7	20.80	3.03	10.03
4.25	3	17.77	2.59	5.59
4.50	2	15.18	2.21	4.21
4.75	1	12.97	1.88	2.88
5.00	1	11.09	1.62	2.62
5.25	1	9.47	1.38	2.38
5.50	2	8.09	1.17	3.17
5.75	1	6.92	1.38	2.38
6.00	2	5.54	1.53	3.53
6.25	2	4.01	1.10	3.10
6.50	0	2.91	0.80	0.80
6.75	2	2.11	0.58	2.58
7.00	0	1.53	0.42	0.42
7.25	0	1.11	0.31	0.31
7.50	0	0.80	0.22	0.22
7.75	0	0.58	0.16	0.16
8.00	0	0.42	0.11	0.11
8.25	0	0.31	0.09	0.09
8.50	0	0.22	0.22	0.22

APPENDIX C

THE FEBRUARY 4, 1976 GUATEMALAN EARTHQUAKE

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THE FEBRUARY 4, 1976 GUATEMALAN EARTHQUAKE

C-1 Introduction:

On February 4, 1976 at 3:01 a.m. (local Guatemalan time), central Guatemala experienced a major earthquake. The surface-wave magnitude (Ms) of this earthquake was 7.5, and the body-wave magnitude (Mb), 5.8. The hypocentral location was 15.32°N latitude and 89.08°W longitude, with a focal depth of about five kilometers. Numerous aftershocks followed the main earthquake, the largest of which occurred on February 6, 1976, causing additional damage to and around Guatemala City. The Mb of the February 6 earthquake was about 5.8. Damage due to the earthquake resulted from 1) direct seismic shaking of structures, particularly those of poor construction such as adobe buildings, 2) fault rupture, 3) earthquake induced lateral spreading and cracking of unconsolidated deposits and 4) a variety of earthquake triggered landslides.

C-2 Intensity:

The maximum intensity of shaking within Guatemala City and the Mixco area, based on the nature and amount of damage to man-made structures whose foundations did not fail, was IX on the Modified Mercalli Scale, with small pockets of higher intensity occurring in different zones throughout the city. MM Intensity IX is defined as follows: "severe damage to well built and ordinary masonry structures, collapse of unreinforced masonry (adobe) structures, some damage to earthquake resistant structures" (see Section C-3).

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Outside of Guatemala City, Modified Mercalli Intensity VI was reached over an area of 33,000 square kilometers, commonly in close proximity to the rupture zone (see Figure C-1). MM Intensity VI is defined as "objects fall from walls and shelves, some damage to poorly constructed masonry (adobe) structures".

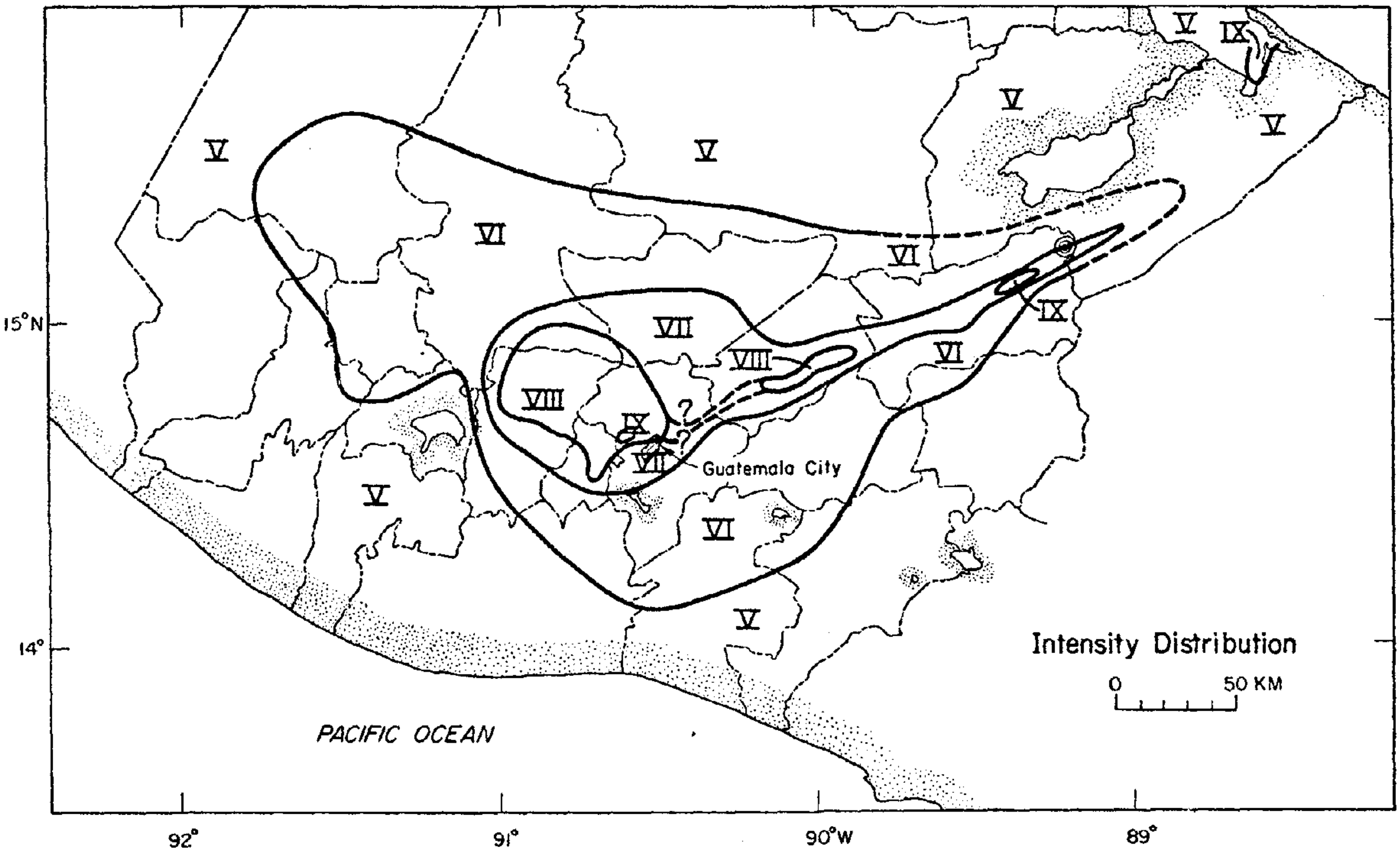

Figure C-1. Isoseismal Map showing Modified Mercalli intensity distribution in Guatemala from the February 4, 1976 earthquake.

indicates epicenter location.
(From USGS PP1002)

C-3 Damage:

The zone of significant damage due to the earthquake and aftershocks extends about 300 kilometers in the east-west direction and 70 kilometers in the north-south direction, coinciding approximately with the region of fault rupture (see Figure C-2). The felt area for this earthquake was at least 100,000 square kilometers.

Severe damage occurred in the areas around and including Guatemala City, Joyobaj and Chimaltenango, and from El Progreso west to Gualan. A few towns up to 200 kilometers away from the instrumental epicenter were completely destroyed.

Foundation failures involving downslope slumping and/or sliding, particularly of loosely consolidated pumiceous pyroclastic rocks of the Guatemalan Highlands, lateral spreading, liquefaction and differential compaction of unconsolidated or poorly consolidated deposits damaged numerous buildings and roads throughout central Guatemala. (See Figure C-3).

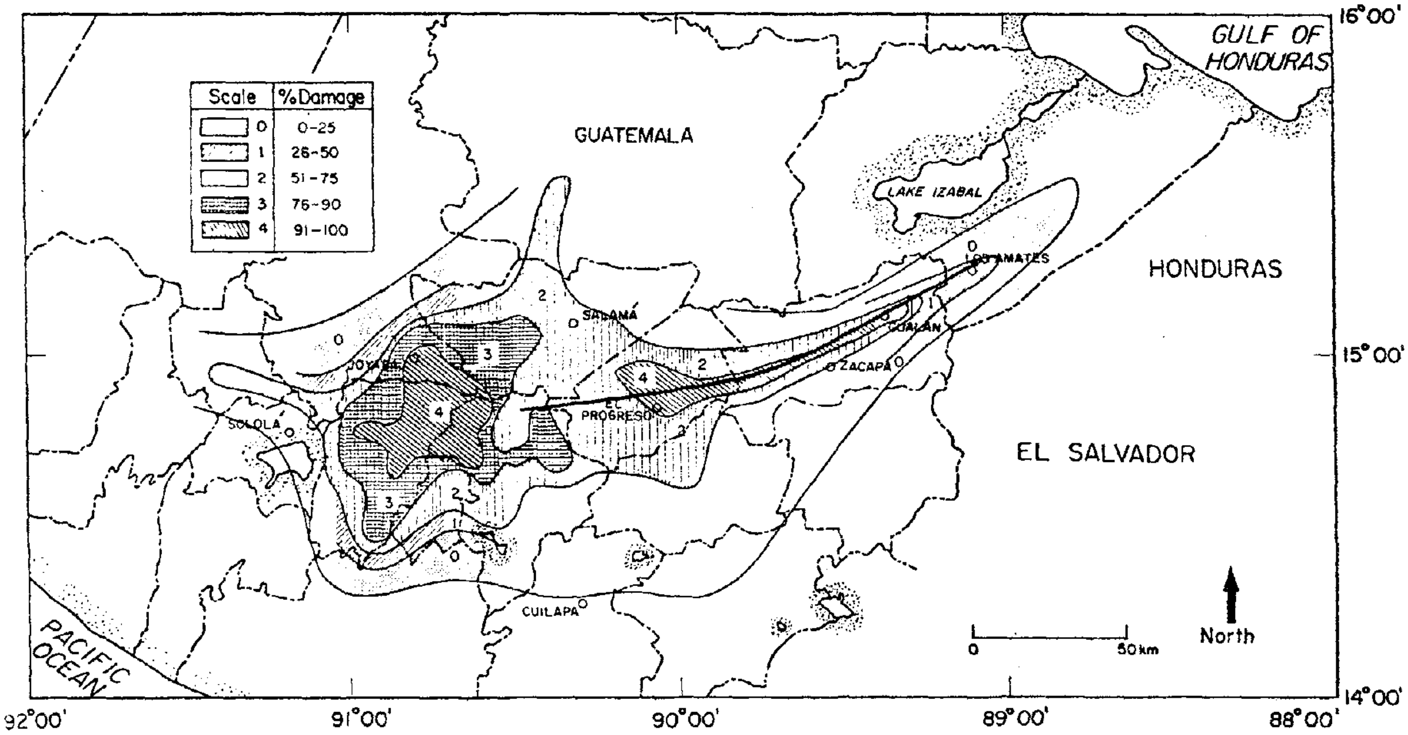

Figure C-2. Contour map showing damage to adobe-type structures in Guatemala due to the February 4, 1976 earthquake. (From USGS PP1002)

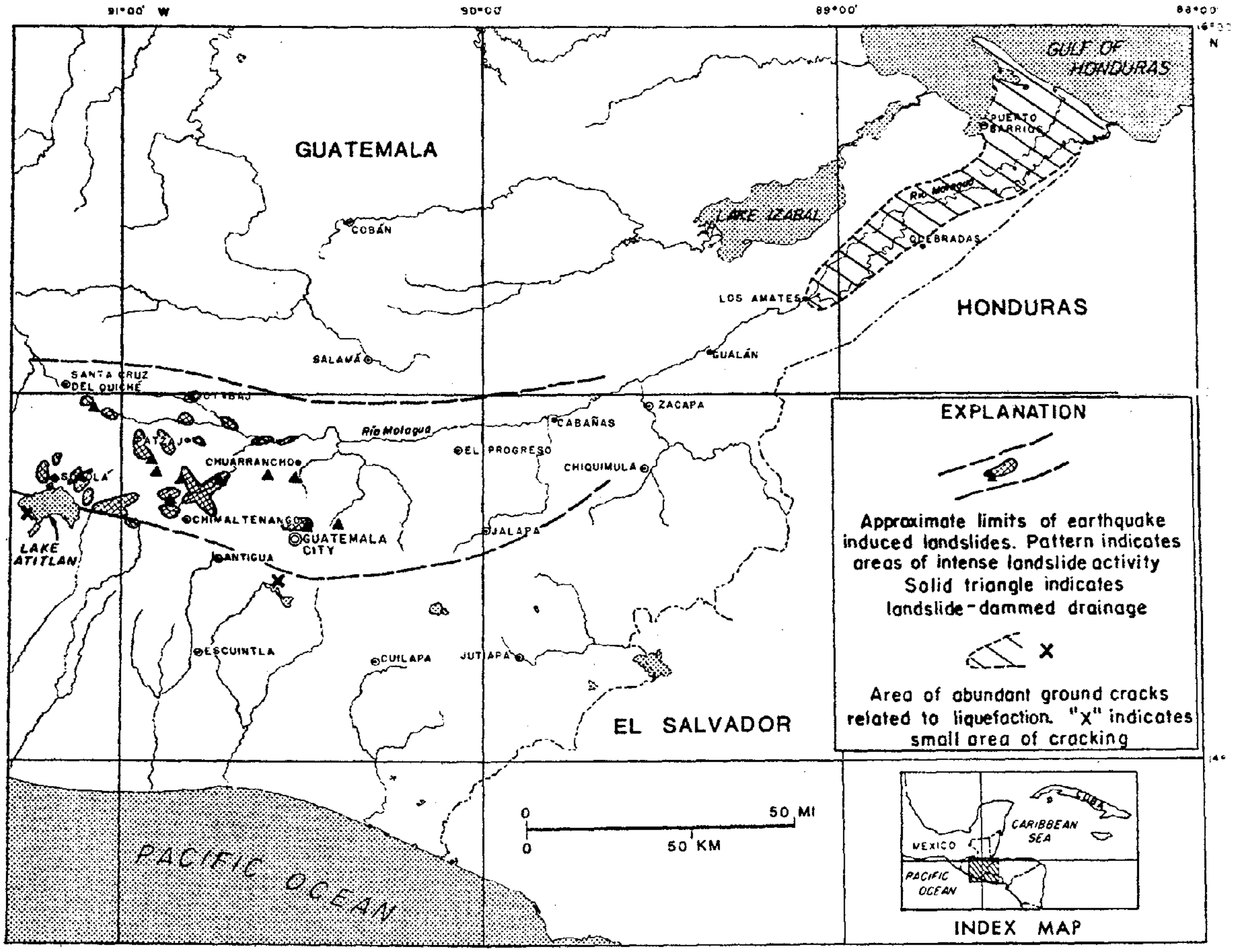

Figure C-3. Areas of earthquake-induced landsliding and of ground cracks probably related to liquefaction of unconsolidated deposits. (From USGS PP1002)

C-4 Hypocenter Location:

The hypocenter location of the main shock was determined by the National Earthquake Information Service (NEIS). The epicenter of this event was located near Los Amates, within the Motagua Valley, about 157 kilometers northeast of Guatemala City. The wide distribution of the 90 recording stations used in locating the epicenter gives reasonable confidence in the epicenter solution. However, a location bias of tens of kilometers is possible, due to undetected seismic wave travel-time anomalies.

The depth of the hypocenter could not be reliably determined instrumentally because of the location of the seismic recording stations and the nature of the seismic waves recorded. A shallow depth of about five kilometers was assigned because of the surface faulting observed accompanying the earthquake and because of the shallow (0-12 km) depth of the aftershocks.

C-5 Nature and Amount of Fault Movement:

Movement along the Motagua fault was predominantly left lateral strike-slip, although minor vertical displacement was also observed. The length of surface faulting observed during field investigations by Plafker and others was 230 kilometers in the Motagua Valley and mountainous area west of the valley (see Figure C-4). The length of the main break, based on the occurrence of aftershocks is about 270 kilometers.

The main trace of the surface fault consists of right stepping en echelon fractures, forming a zone one to three meters wide. These fractures have a more northerly orientation than the overall trend of the fault zone.

The maximum horizontal displacement observed along the main trace of the fault was 325 centimeters, in the area between El Progreso and Chuarrancho (Espinosa, 1976). The average horizontal displacement was about 100 centimeters.

Subsidiary faults and splays of the Motagua fault appeared to be scarce. Secondary faulting (faults which underwent surface displacement approximately concurrent with that on the main fault but which at the surface do not join the main fault), however, occurred associated with

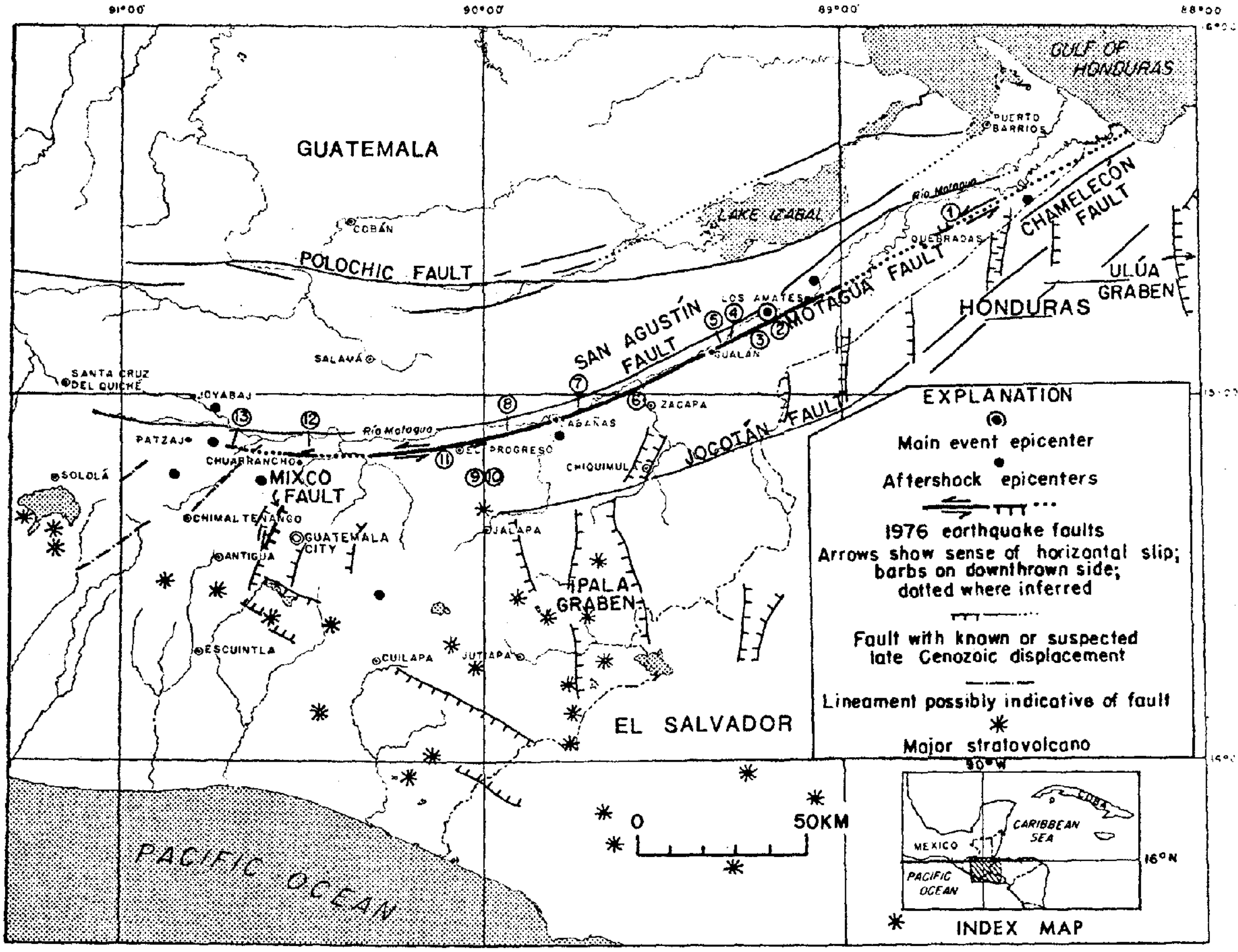

Figure C-4. Fault map of central Guatemala showing faults active during February 1976 earthquakes (heavy line) and other faults in the area (light lines). Epicenter of main event and major after shocks also shown (circles). (From USGS PP1002) the earthquake. This faulting ruptured the ground surface in the Mixco area, west of Guatemala City, as much as 30 kilometers from the main fault trace. Ground rupture occurred along three generally north to north-northeast trending zones with predominantly vertical displacement on the order of 5 to 12 centimeters.

C-6 Cause of the Earthquake:

The February 4, 1976 earthquake occurred due to sinistral (left lateral) motions along the active plate boundary between the North American and Caribbean Plates. The North American Plate is moving westward relative to the Caribbean Plate, producing a strain accumulation along the margin of the two plates. When this situation reaches a critical point, the crust yields, producing an earthquake, as occurred on February 4, 1976. The faulting and earthquakes associated with the Mixco fault are likely due to extension produced by the plate motions and complexities related to the Cocos-Caribbean-North American triple junction.

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APPENDIX D

EARTHQUAKE DATA

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Data File Indices

CGS:	Coast and Geodetic Survey
CGS-B:	Coast and Geodetic Survey Seismological Bulletin
CGSPDE:	Coast and Geodetic Survey Preliminary Determination of Epicenters
ERL:	Environmental Research Laboratories (NOAA)
NOS:	National Ocean Survey (NOAA)
ISS:	World Tape of Epicenters
GUTE:	Gutenberg

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*****************************************************************************

EARTHQUAKE DATA IN CHRONOLOGICAL ORDER

*****************************************************************************
 D S    D  M  Y  H  M  S                                                M
 A O    A  O  E  O  I  E      L          L         D    M               A
 T U    Y  N  A  U  N  C      A          O         E    B               G
 A R       T  R  R  U  O      T          N         P                    N
   C       H        T  N      I          G         T    M               I
   E                E  D      T          I         H    A               T
                              U          T              G               U
                              D          U                              D
                              E          D                              E
                                         E
*****************************************************************************
CFR    19 04 02 02 23 00.0 14.000N  91.000W   25   0        8.30PAL   8.30
CFR    23 09 02 20 18 00.0 15.000N  93.000W   25   0        8.40PAL   8.40
GUTE   12 06 12 12 43 42.0 17.000N  89.000W    0   0        6.80PAL   6.80
GUTE   30 03 14 00 41 18.0 17.000N  92.000W  150   0        7.50PAL   7.50
GUTE   07 09 15 01 20 48.0 14.000N  89.000W   80   0        7.90PAL   7.90
GUTE   17 04 19 20 53 03.0 14.500N  91.750W    0   0        7.00PAL   7.00
GUTE   29 06 19 23 14 23.0 13.500N  86.500W   90   0        6.75PAL   6.75
GUTE   04 02 21 08 22 44.0 13.000N  91.000W  120   0        7.50PAL   7.50
GUTE   28 03 21 07 49 22.0 12.500N  87.500W    0   0        7.30PAL   7.30
GUTE   08 02 26 15 17 49.0 13.000N  89.000W    0   0        7.10PAL   7.10
GUTE   07 02 31 03 30 35.0 13.000N  87.000W  100   0        5.75PAL   5.75
GUTE   25 08 31 22 20 42.0 12.500N  89.500W    0   0        5.60PAL   5.50
GUTE   26 09 31 19 50 30.0 15.000N  92.000W   60   0        6.00PAL   6.00
GUTE   26 09 31 20 03 07.0 14.500N  91.500W    0   0        6.25PAL   6.25
GUTE   22 05 32 22 40 02.0 14.250N  90.000W   80   0        6.00PAL   6.00
GUTE   20 06 32 09 01 47.0 12.500N  89.000W   80   0        6.00PAL   6.00
GUTE   17 08 32 08 46 53.0 15.500N  91.500W   40   0        5.60PAL   5.60
GUTE   19 12 32 06 28 45.0 14.000N  92.500W    0   0        5.60PAL   5.60
GUTE   24 02 34 05 33 30.0 12.750N  86.750W  200   0        6.00PAL   6.00
GUTE   07 03 34 22 41 47.0 13.250N  87.750W    0   0        6.25PAL   6.25
GUTE   19 05 34 10 47 37.0 14.750N  91.250W  120   0        6.25PAL   6.25
GUTE   27 07 34 02 25 45.0 16.000N  92.500W   50   0        6.25PAL   6.25
GUTE   03 12 34 02 38 29.0 13.500N  88.750W    0   0        6.25PAL   6.25
GUTE   17 03 35 21 33 18.0 14.500N  92.000W  110   0        5.75PAL   5.75
GUTE   24 04 35 18 51 40.0 15.250N  93.000W   50   0        6.25PAL   6.25
GUTE   14 12 35 22 05 17.0 14.750N  92.500W    0   0        7.30PAL   7.30
GUTE   27 04 36 06 31 01.0 17.000N  87.000W    0   0        5.60PAL   5.60
GUTE   27 04 36 06 31 01.0 17.000N  87.000W    0   0        5.60PAL   5.60
GUTE   28 05 37 15 35 53.0 17.000N  93.000W  150   0        6.50PAL   6.50
GUTE   08 06 37 22 29 39.0 16.000N  93.000W  200   0        6.25PAL   6.25
GUTE   05 12 37 05 42 09.0 14.000N  91.000W   80   0        5.50PAL   5.50
GUTE   20 01 39 20 40 27.0 13.500N  91.500W   70   0        6.50PAL   6.50
GUTE   08 07 39 21 31 44.0 12.500N  88.000W   90   0        5.50PAL   5.50
GUTE   28 09 39 14 58 27.0 15.500N  91.500W  110   0        6.25PAL   6.25
GUTE   05 12 39 08 30 07.0 14.500N  91.500W    0   0        6.75PAL   6.75
GUTE   12 12 39 02 50 12.0 13.500N  91.750W  240   0        5.50PAL   5.50
GUTE   26 12 39 11 55 11.0 13.250N  88.250W   75   0        6.00PAL   6.00
GUTE   27 07 40 13 32 30.0 14.250N  91.500W   90   0        6.75PAL   6.75
GUTE   27 06 41 17 11 44.0 17.750N  92.250W  220   0        6.25PAL   6.25
GUTE   16 11 41 09 39 46.0 13.250N  88.500W   80   0        5.75PAL   5.75
GUTE   11 04 42 01 25 12.0 14.750N  91.500W  140   0        6.50PAL   6.50
GUTE   06 08 42 23 35 59.0 14.000N  91.000W    0   0        8.30PAL   8.30
GUTE   08 08 42 22 36 34.0 14.250N  91.500W    0   0        6.50PAL   6.50
GUTE   31 08 43 16 10 40.0 14.250N  91.500W   80   0        6.75PAL   6.75
GUTE   23 09 43 15 00 44.0 15.000N  91.500W  110   0        6.75PAL   6.75
GUTE   28 06 44 07 58 54.0 15.000N  92.500W    0   0        7.00PAL   7.00
GUTE   24 08 44 23 37 54.0 15.000N  93.500W  100   0        6.00PAL   6.00
GUTE   02 10 44 17 22 00.0 14.500N  89.750W  160   0        6.50PAL   6.50
GUTE   12 01 45 21 59 29.0 16.000N  93.000W  110   0        5.75PAL   5.75
GUTE   27 10 45 11 24 41.0 15.000N  91.250W  200   0        6.75PAL   6.75
GUTE   05 01 46 01 15 11.0 15.000N  91.000W  210   0        6.00PAL   6.00
GUTE   22 02 46 17 24 52.0 16.250N  92.500W  170   0        6.00PAL   6.00
GUTE   24 06 46 15 48 20.0 14.750N  89.000W  260   0        6.00PAL   6.00
GUTE   26 06 46 07 53 40.0 14.750N  90.750W   90   0        6.50PAL   6.50
CGS    08 07 49 12 40 47.0 14.000N  91.500W  100   0        6.00PAL   6.00
CGS    22 12 49 09 30 47.0 15.000N  93.000W  100   0        6.50PAL   6.50
ISS    17 02 50 03 47 16.0 13.900N  90.800W    0   0        6.38PAL   6.38
CGS    23 10 50 17 47 51.0 14.500N  92.000W    0   0        6.50PAL   6.50
GUTE   23 10 50 16 13 20.0 14.500N  91.500W    0   0        7.10PAL   7.10
ISS    23 10 50 23 38 43.0 14.300N  91.700W    0   0        6.10PAL   6.10
CGS    24 10 50 00 52 03.0 15.000N  92.000W    0   0        6.20PAL   6.20
CGS    24 10 50 05 50 15.0 14.500N  92.000W    0   0        6.00BRK   6.00
ISS    28 10 50 22 15 47.0 14.300N  91.700W   64   0        6.25TAL   6.25
CGS    05 11 50 16 35 20.0 14.500N  92.000W    0   0        6.25PAL   6.25
ISS    02 04 51 00 13 37.0 13.000N  90.000W   33   0        6.38PAL   6.38
ISS    06 05 51 23 08 01.0 13.000N  87.800W    0   0        6.50TAL   6.50
ISS    06 05 51 23 03 32.0 13.000N  87.800W   96   0        6.25TAL   6.25
ISS    07 05 51 20 22 21.0 13.000N  87.800W    0   0        6.00TAL   6.00
ISS    25 07 51 18 42 19.0 14.500N  90.500W   64   0        6.25PAL   6.25
ISS    02 08 51 20 30 17.0 13.000N  87.800W   33   0        5.75PAL   5.75
ISS    03 08 51 00 23 58.0 13.000N  87.800W   33   0        6.00PAL   6.00
ISS    03 08 51 05 25 44.0 13.000N  87.800W   33   0        5.50PAL   5.50
ISS    25 10 51 04 06 22.0 15.600N  92.600W   96   0        5.75PAL   5.75
ISS    15 05 52 18 44 13.0 14.500N  92.300W  160   0        5.63PAL   5.63
ISS    16 05 52 05 42 27.0 14.500N  92.300W  160   0        5.75PAL   5.75
ISS    15 07 52 06 06 24.0 14.500N  92.300W   33   0        6.00PAL   6.00
ISS    29 07 53 18 15 36.0 13.000N  90.000W    0   0        6.00PAL   6.00
ISS    24 08 53 13 21 02.0 14.100N  91.400W   96   0        6.50PAL   6.50
ISS    17 11 53 13 29 52.0 13.800N  91.800W    0   0        7.37PAL   7.37
TAC    14 12 53 08 45 10.0 14.717N  93.333W  100   0        5.50TAL   5.50
CGS    05 02 54 15 17 59.0 17.500N  92.500W  100   0        6.25PAL   6.25
CGS    19 02 54 21 34 41.0 12.500N  87.500W    0   0        6.63PAL   6.63
CGS    11 03 54 10 30 10.0 14.500N  90.500W  100   0        5.75PAL   5.75
ISS    01 04 54 23 11 27.0 17.500N  92.600W  128   0        6.00TAL   6.00
CGS    29 07 54 22 23 54.0 17.500N  92.500W    0   0        5.50TAL   5.50
ISS    21 10 54 06 51 44.0 13.900N  90.600W    0   0        6.50PAL   6.50
TAC    22 03 55 13 54 17.0 13.800N  91.783W    0   0        5.80TAL   5.80
CGS    04 04 55 19 24 04.0 13.000N  87.000W    0   0        6.25PAL   6.25
CGS    26 04 55 03 03 34.0 13.500N  89.500W   60   0        6.50PAL   6.50
CGS    28 08 55 20 13 30.0 14.000N  91.000W   60   0        6.75PAL   6.75
ISS    03 09 55 12 36 21.0 13.800N  90.800W   64   0        6.63PAL   6.63
CGS    26 09 55 08 28 20.0 13.500N  92.500W  200   0        6.87PAL   6.87
CGS    09 01 56 17 01 23.0 16.000N  92.000W  200   0        5.80TAL   5.80
TAC    09 01 56 13 11 38.0 14.333N  92.317W  100   0        5.80TAL   5.80
ISS    11 09 56 09 54 37.0 13.540N  91.190W   64   0        6.13PAL   6.13
ISS    04 12 56 23 01 34.0 13.020N  92.220W  102   0        6.00PAL   6.00
CGS    15 05 57 02 11 05.0 17.500N  93.500W  100   0        5.70TAL   5.70
CGS    08 07 57 15 30 33.0 14.500N  91.000W  150   0        6.00BRK   6.00
ISS    21 07 57 06 04 08.0 14.330N  92.110W   38   0        5.88BRK   5.88
SYKES  27 10 57 18 29 10.3 13.970N  88.110W   56   0        4.00PAL   4.00
CGS    07 12 57 08 24 03.0 13.500N  92.000W    0   0        5.60TAL   5.60
CGS    27 06 58 05 44 28.0 13.000N  88.500W   60   0        6.00PAL   6.00
ISS    02 09 58 20 07 00.0 14.500N  92.990W    0   0        5.82STL   5.82
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CGS-B   25 07 63 12 57 49.1 14.200N   92.100W   33 420MB         0        3.45
CGS-B   31 07 63 15 37 20.3 14.500N   92.200W   33 390MB         0        3.00
CGS-B   01 08 63 04 05 04.3 14.100N   92.300W   33 400MB         0        3.12
CGS-B   07 08 63 09 35 38.2 14.500N   91.300W  245 390MB         0        3.00
CGS-B   07 08 63 18 36 46.6 13.500N   90.900W   67 470MB         0        4.28
CGS-B   09 08 63 01 17 37.8 14.200N   92.300W   33 410MB         0        3.29
CGS-B   20 08 63 09 25 38.9 16.000N   92.400W  193 420MB         0        3.45
CGS-B   26 08 63 01 30 08.7 14.400N   91.300W   33 380MB         0        3.00
CGS-B   27 08 63 02 29 51.4 17.500N   92.600W  180 360MB         0        3.00
CGS-B   28 08 63 05 55 51.3 12.500N   87.200W  115 420MB         0        3.45
CGS-B   14 09 63 09 43 52.0 13.000N   91.000W  130 410MB         0        3.29
CGS-B   17 09 63 03 48 09.7 12.600N   87.100W  144 390MB         0        3.00
CGS-B   25 09 63 00 47 38.0 16.500N   86.600W   33 430MB         0        3.62
CGS-B   25 09 63 01 09 39.7 13.500N   87.100W   33 420MB         0        3.45
CGS-B   29 09 63 22 44 02.9 14.400N   91.900W   61 510MB         0        4.95
CGS-B   29 09 63 23 08 20.8 14.500N   92.000W   42 450MB         0        3.95
CGS-B   29 09 63 23 05 22.5 14.500N   92.000W   33 440MB         0        3.79
CGS-B   30 09 63 02 33 14.8 14.500N   92.100W   33 410MB         0        3.29
CGS-B   30 09 63 03 05 38.1 14.100N   91.900W   86 450MB         0        3.95
CGS-B   30 09 63 14 01 20.9 12.900N   89.000W   65 370MB         0        3.00
CGS-B   19 10 63 21 22 25.2 13.200N   89.200W   33 390MB         0        3.00
CGS-B   28 10 63 02 25 07.9 14.800N   90.800W   33 390MB         0        3.00
CGS-B   01 11 63 11 34 55.9 13.600N   90.100W  128 440MB         0        3.79
CGS-B   10 11 63 07 18 07.6 12.900N   88.500W   45 420MB         0        3.45
CGS-B   13 12 63 19 57 27.4 14.500N   91.900W  139 400MB         0        3.12
CGS-B   16 12 63 10 49 52.5 13.900N   90.900W   59 430MB         0        3.62
CGS-B   20 12 63 22 28 31.2 13.200N   88.000W   64 430MB         0        3.62
CGS-B   22 12 63 01 20 11.0 14.300N   93.000W   33 440MB         0        3.79
CGS-B   27 12 63 03 57 09.8 14.500N   90.700W   33 390MB         0        3.00
CGS-B   28 12 63 06 57 09.9 14.400N   92.300W   33 450MB         0        3.95
CGS-B   18 01 64 21 57 14.4 16.100N   89.300W   33 380MB         0        3.00
CGS-B   25 01 64 17 35 04.9 17.000N   86.900W   33 390MB         0        3.00
CGS-B   25 01 64 18 43 26.8 17.100N   87.200W   33 380MB         0        3.00
CGS-B   25 01 64 22 46 18.4 17.000N   86.600W   33 390MB         0        3.00
CGS-B   27 01 64 11 21 14.4 17.000N   87.000W   33 380MB         0        3.00
CGS-B   03 02 64 01 46 27.9 13.500N   88.000W   61 410MB         0        3.29
CGS-B   03 02 64 02 00 47.3 14.400N   92.600W   34 430MB         0        3.62
CGS-B   07 02 64 11 57 19.1 17.200N   93.000W  245 370MB         0        3.00
CGS-B   08 02 64 09 59 17.4 14.400N   91.300W   33 410MB         0        3.29
CGS-B   15 02 64 07 40 38.5 14.100N   92.700W   76 390MB         0        3.00
CGS-B   16 02 64 10 46 24.7 14.600N   92.400W   33 410MB         0        3.29
CGS-B   20 02 64 12 03 18.7 14.500N   93.000W   49 440MB         0        3.79
CGS-B   21 02 64 03 15 07.9 13.000N   92.800W   33 380MB         0        3.00
CGS-B   21 02 64 07 24 08.0 12.800N   87.900W   62 390MB         0        3.00
CGS-B   24 02 64 02 29 12.3 13.000N   87.200W   83 390MB         0        3.00
CGS-B   02 03 64 12 39 17.6 13.900N   91.100W  130 460MB         0        4.12
CGS-B   02 03 64 16 09 46.1 12.500N   88.000W   63 440MB         0        3.79
CGS-B   02 03 64 18 13 58.5 13.500N   90.500W   73 360MB         0        3.00
CGS-B   13 03 64 11 54 06.1 12.900N   90.400W  128 490MB         0        4.62
CGS-B   13 03 64 18 51 15.0 13.700N   90.700W   64 440MB         0        3.79
CGS-B   13 03 64 21 08 12.1 14.500N   90.900W   33 480MB         0        4.45
CGS-B   16 03 64 06 06 51.5 13.500N   88.300W   92 390MB         0        3.00
CGS-B   18 03 64 11 39 26.8 14.700N   92.100W   31 400MB         0        3.12
CGS-B   20 03 64 06 35 51.6 12.900N   89.900W  125 420MB         0        3.45
CGS-B   02 04 64 03 48 59.6 12.500N   87.800W   32 420MB         0        3.45
CGS-B   04 04 64 06 43 20.2 12.500N   87.700W   41 430MB         0        3.62
CGS-B   05 04 64 05 30 12.6 14.200N   91.600W  111 400MB         0        3.12
CGS-B   09 04 64 04 15 23.0 13.500N   89.900W   89 500MB         0        4.78
CGS-B   09 04 64 04 07 58.6 13.500N   90.200W   53 370MB         0        3.00
CGS-B   14 04 64 02 42 04.9 14.100N   91.300W  126 390MB         0        3.00
CGS-B   16 04 64 11 20 25.2 14.000N   90.000W  209 370MB         0        3.00
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TAC     03 09 58 01 53 24.0 14.717N   93.333W    0   0          5.40TAL   5.40
TAC     03 09 58 04 18 08.0 14.533N   92.317W  100   0          6.20TAL   6.20
TAC     25 09 58 17 47 50.0 13.400N   93.083W  100   0          5.30TAL   5.30
ISS     14 11 58 05 46 30.0 14.410N   91.590W   76   0          5.50TAL   5.50
CGS     24 01 59 19 42 20.0 13.000N   92.500W    0   0          6.25PAL   6.25
ISS     16 02 59 17 54 15.0 13.110N   87.340W    0   0          5.40TAL   5.40
ISS     20 02 59 18 16 20.0 13.940N   90.590W   48   0          6.50PAL   6.50
ISS     09 03 59 22 03 03.0 13.090N   90.970W  171   0          6.30TAL   6.30
CGS     11 03 59 14 31 33.0 14.500N   92.000W    0   0          5.00TAL   5.00
CGS     28 04 59 11 09 30.0 13.000N   93.000W    0   0          6.63PAL   6.63
CGS     03 05 59 04 41 24.0 12.500N   87.500W  100   0          5.60TAL   5.60
CGS     15 05 59 07 49 30.0 14.000N   93.000W  100   0          5.20TAL   5.20
ISS     16 06 59 08 02 08.0 14.650N   93.520W   64   0          5.30TAL   5.30
TAC     25 06 59 00 48 24.0 16.250N   93.517W  200   0          5.30TAL   5.30
CGS     10 03 60 18 55 55.0 14.500N   91.500W  100   0          5.40TAL   5.40
CGS     13 04 60 12 37 43.0 13.500N   92.000W   50   0          6.00PAL   6.00
CGS     20 08 60 00 19 35.2 14.500N   91.500W  115   0          6.00PAL   6.00
CGS     13 09 60 17 51 08.9 13.500N   90.500W  104   0          4.25PAL   4.25
CGS     29 09 60 18 54 27.2 13.500N   90.000W   86   0          4.88PAL   4.88
CGS     16 10 60 09 34 44.7 14.000N   91.200W  135   0          5.00PAL   5.00
CGS     17 10 60 22 15 32.0 14.700N   92.800W  128   0          5.88PAL   5.88
CGS     14 11 60 19 59 35.2 14.900N   92.800W  114   0          5.13PAL   5.13
CGS-B   02 03 61 00 04 12.7 13.800N   92.200W   98   0          5.75MAL   5.75
CGS-B   12 04 61 22 20 33.6 13.200N   88.900W  122   0          5.88PAL   5.88
CGS-B   19 05 61 09 25 41.5 12.600N   88.200W   68   0          4.63PAL   4.63
CGS-B   23 05 61 16 44 59.4 12.700N   87.300W  138   0          6.50PAL   6.50
CGS-B   26 05 61 05 06 31.9 13.400N   91.800W  150   0          5.38MAL   5.38
CGS-B   17 06 61 15 07 33.7 14.200N   92.000W   85   0          6.00PAL   6.00
CGS-B   17 06 61 18 39 51.4 14.600N   92.100W  105   0          5.30TAL   5.30
CGS-B   24 06 61 05 07 55.5 13.400N   89.900W   81   0          4.88PAL   4.88
CGS-B   09 07 61 04 57 36.8 16.400N   87.800W   50   0          4.50PAL   4.50
SSS     24 08 61 06 30 35.0 13.500N   89.600W   80   0          4.50SSL   4.50
CGS-B   01 09 61 18 50 35.4 13.600N   92.500W   37   0          6.50PAL   6.50
CGS-B   29 12 61 14 53 19.4 14.500N   92.800W   45   0          5.00TAL   5.00
CGS-B   30 01 62 08 34 23.9 12.700N   87.500W   49   0          4.88PAL   4.88
CGS-B   24 07 62 21 08 22.1 13.400N   92.500W  131   0          5.50BRK   5.50
CGS-B   28 07 62 13 58 39.3 14.300N   93.000W   63   0          4.50PAL   4.50
CGS-B   30 07 62 10 19 38.5 14.600N   93.100W   46   0          4.75PAL   4.75
CGS-B   03 02 63 04 23 18.0 14.800N   91.900W   91 460MB            0      4.12
CGS-B   13 02 63 00 22 51.3 13.900N   91.000W   81 520MB            0      5.11
CGS-B   24 02 63 13 34 14.7 14.700N   91.300W  119 560MB            0      5.78
CGS-B   15 04 63 22 35 58.6 14.300N   91.900W   88 460MB            0      4.12
CGS-B   29 04 63 20 35 39.3 17.600N   92.400W    9 530MB            0      5.28
CGS-B   01 05 63 16 38 52.6 14.000N   91.800W  109 410MB            0      3.29
CGS-B   03 05 63 19 18 14.5 17.600N   91.800W   90 410MB            0      3.29
CGS-B   04 05 63 16 19 27.4 13.600N   90.900W  123 470MB            0      4.28
CGS-B   05 05 63 12 44 43.0 14.300N   91.900W  112 420MB            0      3.45
CGS-B   09 05 63 15 06 24.4 12.700N   86.600W   33 410MB            0      3.29
CGS-B   13 05 63 12 44 01.4 14.500N   92.900W   61 560MB            0      5.78
CGS-B   25 05 63 14 52 27.6 13.100N   89.800W   91 420MB            0      3.45
CGS-B   29 05 63 22 41 36.7 13.900N   91.800W  131 440MB            0      3.79
CGS-B   14 06 63 07 23 13.7 13.500N   93.500W  150 400MB            0      3.12
CGS-B   14 06 63 07 18 50.6 15.000N   93.100W   33 370MB            0      3.00
CGS-B   14 06 63 08 19 16.6 14.000N   93.400W   33 400MB            0      3.12
CGS-B   21 06 63 04 02 53.7 15.000N   91.700W  219 440MB            0      3.79
CGS-B   02 07 63 22 00 48.9 13.700N   88.900W  173 410MB            0      3.29
CGS-B   03 07 63 09 13 30.7 14.600N   92.800W   72 400MB            0      3.12
CGS-B   04 07 63 01 43 20.3 12.600N   88.700W   55 410MB            0      3.29
CGS-B   05 07 63 14 40 54.7 12.800N   88.900W   85 410MB            0      3.29
CGS-B   15 07 63 16 32 18.6 14.400N   90.200W   33 380MB            0      3.00
CGS-B   22 07 63 00 16 33.1 13.500N   89.900W   34 400MB            0      3.12
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CGS-B  17 11 64 16 17 03.0 13.200N  89.600W  54 450MB    0      3.95    CGS-B  24 04 64 14 40 28.3 13.300N  88.800W 158 510MB    0      4.95
CGS-B  27 11 64 10 55 11.3 13.400N  88.700W  33 410MB    0      3.29    CGS-B  26 04 64 01 17 11.7 14.900N  92.500W  45 420MB    0      3.45
CGS-B  27 11 64 23 50 38.4 13.800N  89.400W  33 400MB    0      3.12    CGS-B  06 05 64 01 26 32.1 13.400N  91.400W  69 400MB    0      3.12
CGS-B  03 12 64 02 00 28.6 13.800N  89.000W  41 420MB    0      3.45    CGS-B  15 05 64 02 13 56.6 12.800N  87.500W  51 370MB    0      3.00
CGS-B  09 12 64 14 22 03.1 13.200N  87.200W 200 390MB    0      3.00    CGS-B  19 05 64 04 18 05.9 16.000N  91.800W  33 410MB    0      3.29
CGS-B  14 12 64 21 29 05.8 13.900N  90.500W  33 440MB    0      3.79    CGS-B  27 05 64 04 22 38.0 14.300N  93.500W  63 440MB    0      3.79
CGS-B  15 12 64 12 13 25.8 14.700N  91.700W 118 540MB    0      5.45    CGS-B  28 05 64 06 27 32.8 13.500N  93.100W  33 370MB    0      3.00
CGS-B  01 01 65 11 39 30.5 13.600N  92.900W  33 450MB    0      3.95    CGS-B  30 05 64 20 02 21.7 14.600N  91.800W  23 370MB    0      3.00
CGS-B  05 01 65 06 24 10.1 13.300N  90.800W  33 430MB    0      3.62    CGS-B  15 06 64 09 41 24.2 12.500N  88.300W  56 410MB    0      3.29
CGS-B  05 01 65 14 18 36.2 14.300N  93.300W  53 470MB    0      4.28    CGS-B  15 06 64 11 13 47.3 12.500N  88.000W  14 410MB    0      3.29
CGS-B  05 01 65 19 29 38.0 14.700N  93.100W  47 440MB    0      3.79    CGS-B  19 06 64 13 45 13.2 14.100N  91.400W  85 390MB    0      3.00
CGS-B  07 01 65 11 05 01.4 14.400N  92.700W  69 410MB    0      3.29    CGS-B  24 06 64 19 28 02.6 13.400N  93.300W  33 390MB    0      3.00
CGS-B  10 01 65 02 48 00.8 14.500N  92.200W  33 390MB    0      3.00    CGS-B  25 06 64 05 58 47.1 14.500N  93.400W  69 480MB    0      4.45
CGS-B  11 01 65 04 10 04.4 14.000N  89.500W 144 500MB    0      4.78    CGS-B  28 06 64 07 19 18.5 14.100N  92.000W  98 370MB    0      3.00
CGS-B  11 01 65 16 25 58.4 14.200N  92.000W  33 390MB    0      3.00    CGS-B  03 07 64 02 33 50.0 13.000N  90.900W   8 390MB    0      3.00
CGS-B  13 01 65 06 42 33.0 14.600N  92.100W  33 390MB    0      3.00    CGS-B  03 07 64 11 03 50.4 13.000N  88.200W  60 380MB    0      3.00
CGS-B  14 01 65 19 35 36.0 14.100N  93.100W  33 390MB    0      3.00    CGS-B  06 07 64 05 53 43.7 14.100N  91.200W 119 370MB    0      3.00
CGS-B  14 01 65 23 54 00.4 14.400N  92.900W  33 480MB    0      4.45    CGS-B  06 07 64 09 31 56.2 13.500N  90.400W  33 400MB    0      3.12
CGS-B  15 01 65 06 57 40.0 14.600N  92.800W  33 390MB    0      3.00    CGS-B  07 07 64 22 14 01.8 13.200N  93.200W  90 410MB    0      3.29
CGS-B  16 01 65 05 54 14.1 13.900N  93.000W  33 390MB    0      3.00    CGS-B  09 07 64 10 48 21.5 13.000N  90.200W  56 360MB    0      3.00
CGS-B  19 01 65 09 14 36.8 14.300N  91.700W 121 430MB    0      3.62    CGS-B  11 07 64 11 16 32.8 14.100N  93.000W  51 370MB    0      3.00
CGS-B  23 01 65 05 47 31.6 13.100N  91.800W 166 410MB    0      3.29    CGS-B  20 07 64 08 27 26.6 13.500N  87.900W  87 380MB    0      3.00
CGS-B  25 01 65 08 51 42.4 13.900N  93.500W  33 390MB    0      3.00    CGS-B  21 07 64 07 01 59.3 13.100N  88.400W  68 470MB    0      4.28
CGS-B  01 02 65 15 43 52.8 13.100N  89.600W  62 420MB    0      3.45    CGS-B  21 07 64 18 05 40.2 13.500N  93.200W  33 370MB    0      3.00
CGS-B  02 02 65 01 14 34.0 14.100N  92.400W  33 390MB    0      3.00    CGS-B  24 07 64 01 39 39.0 14.200N  91.600W  65 490MB    0      4.62
CGS-B  02 02 65 03 37 13.9 14.000N  91.000W  33 490MB    0      4.62    CGS-B  26 07 64 03 58 29.6 12.700N  89.600W  65 480MB    0      4.45
CGS-B  02 02 65 03 46 36.2 14.300N  90.400W  94 460MB    0      4.12    CGS-B  29 07 64 09 46 42.2 14.900N  93.400W  56 410MB    0      3.29
CGS-B  03 02 65 18 35 11.6 13.100N  90.300W  33 410MB    0      3.29    CGS-B  31 07 64 12 44 52.0 14.400N  88.900W  68 380MB    0      3.00
CGS-B  03 02 65 18 28 51.7 13.900N  92.000W  56 470MB    0      4.28    CGS-B  05 08 64 02 54 38.2 14.500N  92.100W  33 390MB    0      3.00
CGS-B  05 02 65 08 35 24.2 13.200N  93.500W  17 410MB    0      3.29    CGS-B  07 08 64 03 15 25.2 14.300N  92.000W  33 380MB    0      3.00
CGS-B  05 02 65 08 00 22.1 13.500N  93.200W  33 370MB    0      3.00    CGS-B  07 08 64 15 31 18.0 14.000N  91.900W  89 500MB    0      4.78
CGS-B  06 02 65 08 14 08.8 13.800N  89.300W  16 430MB    0      3.62    CGS-B  08 08 64 15 45 10.9 12.500N  87.800W  63 580MB    0      6.11
CGS-B  10 02 65 19 30 43.2 13.000N  89.500W  55 400MB    0      3.12    CGS-B  16 08 64 07 30 12.4 13.300N  87.600W  60 390MB    0      3.00
CGS-B  15 02 65 15 03 14.2 14.200N  92.400W  41 390MB    0      3.00    CGS-B  21 08 64 03 29 18.7 13.900N  93.000W  33 440MB    0      3.79
CGS-B  16 02 65 10 54 39.7 13.400N  91.200W  97 410MB    0      3.29    CGS-B  26 08 64 09 00 19.5 13.900N  92.600W  33 390MB    0      3.00
CGS-B  23 02 65 00 08 41.1 16.100N  93.400W  33 410MB    0      3.29    CGS-B  30 08 64 15 20 50.7 12.600N  88.500W  54 460MB    0      4.12
CGS-B  24 02 65 00 26 45.8 13.700N  92.100W  87 450MB    0      3.95    CGS-B  12 09 64 21 19 38.7 12.500N  89.100W  55 420MB    0      3.45
CGS-B  24 02 65 08 09 17.2 14.000N  92.200W  56 500MB    0      4.78    CGS-B  13 09 64 11 52 18.7 16.300N  91.800W 234 380MB    0      3.00
CGS-B  24 02 65 09 37 17.6 14.200N  92.100W  33 510MB    0      4.95    CGS-B  14 09 64 13 33 33.7 13.000N  93.200W  64 490MB    0      4.62
CGS-B  24 02 65 21 09 12.2 13.300N  92.200W 262 420MB    0      3.45    CGS-B  14 09 64 15 45 22.2 13.500N  90.800W  38 480MB    0      4.45
CGS-B  28 02 65 06 56 51.7 12.800N  89.700W  97 400MB    0      3.12    CGS-B  15 09 64 05 09 23.2 13.100N  91.000W  33 380MB    0      3.00
CGS-B  01 03 65 21 32 11.8 13.400N  92.500W  93 590MB    0      6.28    CGS-B  15 09 64 07 51 28.6 13.400N  90.600W  33 390MB    0      3.00
CGS-B  04 03 65 02 44 51.4 13.900N  93.500W  33 400MB    0      3.12    CGS-B  15 09 64 21 56 07.2 13.300N  90.800W  74 440MB    0      3.79
CGS-B  22 03 65 07 53 07.4 13.900N  90.900W  60 450MB    0      3.95    CGS-B  22 09 64 13 27 29.7 13.300N  89.700W  78 480MB    0      4.45
CGS-B  30 03 65 14 01 00.2 13.600N  90.800W  33 430MB    0      3.62    CGS-B  25 09 64 01 54 17.6 13.300N  89.400W  94 400MB    0      3.12
CGS-B  02 04 65 01 13 29.5 13.800N  90.800W  33 390MB    0      3.00    CGS-B  28 09 64 03 20 59.4 13.300N  90.100W  72 380MB    0      3.00
CGS-B  06 04 65 16 53 57.8 14.200N  92.600W  57 500MB    0      4.78    CGS-B  28 09 64 05 25 12.1 13.600N  90.000W  33 430MB    0      3.62
CGS-B  13 04 65 01 17 30.8 13.900N  92.000W  33 410MB    0      3.29    CGS-B  29 09 64 06 30 30.6 13.800N  93.300W  33 390MB    0      3.00
CGS-B  16 04 65 03 57 55.0 14.000N  91.800W  17 400MB    0      3.12    CGS-B  01 10 64 18 19 43.8 13.600N  90.100W  62 440MB    0      3.79
CGS-B  16 04 65 04 53 02.8 14.600N  91.600W  75 420MB    0      3.45    CGS-B  05 10 64 22 58 04.9 13.800N  91.300W  33 440MB    0      3.79
CGS-B  16 04 65 11 01 52.4 14.000N  91.500W  65 450MB    0      3.95    CGS-B  14 10 64 21 05 07.0 13.300N  93.000W  44 400MB    0      3.12
CGS-B  16 04 65 13 38 59.8 13.700N  91.700W  78 420MB    0      3.45    CGS-B  20 10 64 23 48 13.9 13.600N  92.200W  33 390MB    0      3.00
CGS-B  17 04 65 07 02 50.1 14.100N  91.300W  33 360MB    0      3.00    CGS-B  22 10 64 15 10 58.5 13.700N  91.400W  33 380MB    0      3.00
CGS-B  18 04 65 21 13 37.0 14.000N  91.800W  33 420MB    0      3.45    CGS-B  23 10 64 15 21 56.6 13.200N  91.600W  45 400MB    0      3.12
CGS-B  20 04 65 12 44 58.1 14.300N  91.800W  96 390MB    0      3.00    CGS-B  29 10 64 12 21 52.9 13.200N  88.500W  33 400MB    0      3.12
CGS-B  20 04 65 13 12 46.4 14.300N  92.200W  84 440MB    0      3.79    CGS-B  01 11 64 12 07 59.0 13.900N  92.300W  33 390MB    0      3.00
CGS-B  03 05 65 10 01 35.2 13.300N  89.300W  23 510MB    0      4.95    CGS-B  07 11 64 20 21 12.1 13.000N  90.100W  73 410MB    0      3.29
CGS-B  26 05 65 04 58 39.2 13.700N  90.600W  39 520MB    0      5.11    CGS-B  07 11 64 20 07 04.4 13.100N  89.900W  82 430MB    0      3.62
CGS-B  06 06 65 03 37 37.0 12.700N  90.100W  30 400MB    0      3.12    CGS-B  09 11 64 09 56 10.5 14.000N  92.200W  61 380MB    0      3.00
CGS-B  08 06 65 09 15 14.6 13.400N  91.800W  42 370MB    0      3.00    CGS-B  10 11 64 19 13 25.1 12.500N  90.300W  33 420MB    0      3.45
CGS-B  11 06 65 22 33 06.5 13.200N  91.000W  33 390MB    0      3.00    CGS-B  13 11 64 08 02 38.5 13.000N  88.600W  86 490MB    0      4.62
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CGS-B  07 03 66 11 15 27.9 14.000N  93.200W   33 400MB    0   3.12
CGS-B  12 03 66 00 53 22.7 14.900N  92.700W   60 430MB    0   3.62
CGS-B  18 03 66 21 55 56.4 13.300N  90.900W   40 430MB    0   3.62
CGS-B  22 03 66 03 41 47.4 13.100N  90.000W   20 480MB    0   4.45
CGS-B  27 03 66 21 07 30.4 14.500N  93.500W   33 370MB    0   3.00
CGS-B  03 04 66 18 14 24.4 14.700N  92.700W   33 370MB    0   3.00
CGS-B  04 04 66 19 50 07.1 13.800N  89.700W  102 510MB    0   4.95
CGS-B  12 04 66 03 34 22.4 12.500N  87.600W  104 390MB    0   3.00
CGS-B  12 04 66 17 30 49.2 12.500N  88.000W   33 440MB    0   3.79
CGS-B  13 04 66 00 54 42.7 14.100N  92.500W   60 460MB    0   4.12
CGS-B  14 04 66 05 35 10.6 14.500N  93.200W   33 390MB    0   3.00
CGS-B  14 04 66 06 54 34.6 14.400N  93.400W   33 370MB    0   3.00
CGS-B  14 04 66 12 43 20.0 13.000N  93.300W   46 390MB    0   3.00
CGS-B  21 04 66 06 09 39.8 14.000N  90.800W   66 400MB    0   3.12
CGS-B  24 04 66 06 03 50.8 12.900N  89.200W   47 430MB    0   3.62
CGS-B  24 04 66 15 41 03.2 13.700N  88.300W   33 390MB    0   3.00
CGS-B  03 05 66 12 45 30.3 13.900N  92.900W   53 430MB    0   3.62
CGS-B  04 05 66 18 13 55.7 12.500N  87.700W   68 510MB    0   4.95
CGS-B  09 05 66 03 40 57.0 13.700N  91.200W   23 440MB    0   3.79
CGS-B  20 05 66 03 51 18.1 14.800N  91.700W   33 400MB    0   3.12
CGS-B  01 06 66 02 52 05.9 14.700N  91.200W   26 360MB    0   3.00
CGS-B  04 06 66 14 12 53.3 13.200N  90.100W   55 440MB    0   3.79
CGS-B  22 06 66 07 11 01.7 14.700N  92.000W   93 480MB    0   4.45
CGS-B  23 06 66 09 01 48.1 13.400N  90.300W   33 400MB    0   3.12
CGS-B  23 06 66 13 33 36.8 14.600N  91.300W   33 420MB    0   3.45
CGS-B  25 06 66 17 24 39.2 13.900N  91.100W  103 510MB    0   4.95
CGS-B  25 06 66 21 56 57.7 14.000N  91.700W   33 380MB    0   3.00
CGS-B  01 07 66 20 17 49.2 13.700N  88.400W  201 460MB    0   4.12
CGS-B  03 07 66 05 22 12.5 14.300N  92.700W   33 380MB    0   3.00
CGS-B  05 07 66 04 05 02.9 13.700N  90.800W   53 400MB    0   3.12
CGS-B  08 07 66 01 12 04.7 13.000N  91.900W   33 370MB    0   3.00
CGS-B  13 07 66 08 20 58.8 12.500N  87.800W   56 530MB    0   5.28
CGS-B  14 07 66 23 28 08.5 13.400N  91.600W   36 400MB    0   3.12
CGS-B  17 07 66 20 44 27.0 13.400N  91.500W   33 400MB    0   3.12
CGS-B  25 07 66 00 42 58.9 13.200N  87.800W  210 400MB    0   3.12
CGS-B  01 08 66 07 42 00.4 14.500N  92.800W   55 410MB    0   3.29
CGS-B  03 08 66 10 24 39.7 17.600N  92.400W   33 380MB    0   3.00
CGS-B  07 08 65 05 33 40.6 13.400N  89.900W   74 440MB    0   3.79
CGS-B  12 08 66 08 53 36.5 14.700N  91.100W   33 380MB    0   3.00
CGS-B  12 08 66 08 53 36.5 14.700N  91.100W   33 380MB    0   3.00
CGS-B  12 08 66 14 40 56.0 14.300N  89.900W   77 380MB    0   3.00
CGS-B  16 08 66 15 00 44.9 14.500N  93.000W   33 430MB    0   3.62
CGS-B  18 08 66 10 33 17.7 14.800N  91.700W   85 560MB    0   5.78
CGS-B  18 08 66 19 40 52.2 14.900N  91.900W   33 370MB    0   3.00
CGS-B  19 08 66 01 48 22.3 14.400N  93.000W   33 390MB    0   3.00
CGS-B  25 08 65 12 04 20.3 12.500N  89.300W   73 440MB    0   3.79
CGS-B  26 08 66 08 42 37.5 13.400N  93.500W  112 400MB    0   3.12
CGS-B  29 08 65 17 35 22.3 13.500N  90.900W   33 380MB    0   3.00
CGS-B  30 08 66 05 29 47.8 14.300N  92.300W   79 420MB    0   3.45
CGS-B  03 09 65 06 38 07.2 13.800N  91.200W   62 440MB    0   3.79
CGS-B  08 09 66 06 43 14.3 14.700N  91.500W   62 350MB    0   3.00
CGS-B  10 09 66 04 13 01.7 14.500N  92.900W   33 370MB    0   3.00
CGS-B  16 09 65 14 52 50.3 14.100N  91.400W   61 440MB    0   3.79
CGS-B  18 09 66 10 51 08.9 13.200N  89.600W   66 410MB    0   3.29
CGS-B  20 09 65 03 53 34.1 13.100N  88.200W   81 400MB    0   3.12
CGS-B  20 09 66 09 51 07.7 13.800N  89.000W    8 440MB    0   3.79
CGS-B  23 09 66 19 01 54.3 12.900N  89.500W   65 440MB    0   3.79
CGS-B  02 10 66 12 22 24.5 13.400N  92.300W   39 420MB    0   3.45
CGS-3  19 10 66 06 13 06.6 14.000N  91.600W   35 410MB    0   3.29
CGS-3  20 10 66 03 40 07.2 13.100N  89.700W   67 410MB    0   3.29
CGS-B  20 10 65 18 28 40.5 13.500N  91.800W    5 440MB    0   3.79
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CGS-B  12 06 65 16 35 43.8 13.700N  91.000W   33 450MB    0   3.95
CGS-B  14 06 65 23 19 44.2 14.400N  92.100W   33 410MB    0   3.29
CGS-B  19 06 65 01 39 38.7 13.100N  90.400W   32 460MB    0   4.12
CGS-B  27 06 65 13 08 28.6 12.000N  87.900W   33 410MB    0   3.29
CGS-B  13 07 65 00 36 31.5 13.300N  92.000W  123 500MB    0   4.78
CGS-B  26 07 65 13 06 10.3 14.900N  90.900W  133 380MB    0   3.00
CGS-B  28 07 65 13 55 05.0 14.000N  91.900W   33 390MB    0   3.00
CGS-B  28 07 65 13 20 14.5 14.500N  90.300W  220 430MB    0   3.62
CGS-B  05 08 65 19 05 07.7 14.800N  91.000W   59 400MB    0   3.12
CGS-B  11 08 65 02 54 48.4 14.700N  92.900W  111 440MB    0   3.79
CGS-B  15 08 65 04 12 56.0 14.600N  92.300W  168 410MB    0   3.29
CGS-B  17 08 65 14 02 19.2 13.000N  92.100W  137 500MB    0   4.78
CGS-B  27 08 65 07 51 34.2 13.100N  92.700W  128 410MB    0   3.29
CGS-B  27 08 65 08 42 44.1 13.400N  92.800W   73 400MB    0   3.12
CGS-B  29 08 65 01 26 07.6 14.800N  91.500W   33 390MB    0   3.00
CGS-B  29 08 65 01 45 54.4 14.000N  90.600W   85 510MB    0   4.95
CGS-B  29 08 65 02 32 51.3 14.000N  90.900W   28 440MB    0   3.79
CGS-B  31 08 65 23 18 05.3 13.400N  92.000W   26 470MB    0   4.28
CGS-B  06 09 65 08 35 05.3 13.500N  91.100W   88 400MB    0   3.12
CGS-B  27 09 65 17 37 53.8 12.900N  88.400W   33 420MB    0   3.45
CGS-B  02 10 65 23 03 06.1 13.700N  90.700W   69 390MB    0   3.00
CGS-B  09 10 65 09 37 07.5 16.000N  91.600W  211 450MB    0   3.95
CGS-B  14 10 65 08 30 03.3 13.200N  90.800W  106 370MB    0   3.00
CGS-B  14 10 65 10 17 23.9 12.500N  88.300W   96 380MB    0   3.00
CGS-B  20 10 65 23 54 30.4 12.500N  87.300W   72 540MB    0   5.45
CGS-B  20 10 65 23 54 51.3 12.700N  87.000W   91 560MB    0   5.78
CGS-B  26 10 65 14 58 55.1 13.900N  91.400W  155 430MB    0   3.62
CGS-B  30 10 65 12 47 10.0 14.700N  92.500W   65 410MB    0   3.29
CGS-B  12 11 65 13 40 34.7 14.200N  92.200W   33 370MB    0   3.00
CGS-B  21 11 65 03 30 58.0 13.600N  92.200W   68 440MB    0   3.79
CGS-B  30 11 65 03 51 58.0 16.900N  93.200W  113 380MB    0   3.00
CGS-B  06 12 65 04 39 10.4 12.500N  87.300W   50 450MB    0   3.95
CGS-B  11 12 65 15 30 09.1 14.200N  90.800W   33 420MB    0   3.45
CGS-B  11 12 65 19 20 43.6 14.100N  90.900W   33 410MB    0   3.29
CGS-B  11 12 65 23 52 59.3 13.400N  89.300W   57 410MB    0   3.29
CGS-B  14 12 65 14 21 05.9 14.500N  89.700W  273 490MB    0   4.62
CGS-B  16 12 65 05 23 06.3 12.600N  88.800W  152 440MB    0   3.79
CGS-B  23 12 65 02 44 54.8 14.700N  92.600W   65 420MB    0   3.45
CGS-B  23 12 65 07 56 11.0 14.500N  92.500W   94 390MB    0   3.00
CGS-B  23 12 65 11 43 03.8 14.700N  92.500W   74 440MB    0   3.79
CGS-B  23 12 65 11 13 26.0 16.100N  92.700W  243 400MB    0   3.12
CGS-B  24 12 65 22 57 16.3 12.500N  89.000W  118 450MB    0   3.95
CGS-B  25 12 65 04 13 29.7 13.900N  89.400W   33 430MB    0   3.62
CGS-B  17 01 66 14 42 19.9 14.100N  92.100W   75 480MB    0   4.45
CGS-B  19 01 66 04 24 58.1 14.100N  92.400W   33 410MB    0   3.29
CGS-B  29 01 66 14 40 30.5 16.500N  91.200W   33 470MB    0   4.28
CGS-B  01 02 66 11 41 29.1 14.900N  93.500W   33 430MB    0   3.62
CGS-B  08 02 66 02 59 26.3 14.900N  92.900W   13 420MB    0   3.45
CGS-B  08 02 66 05 11 51.2 14.300N  93.100W   33 390MB    0   3.00
CGS-B  08 02 66 06 19 52.7 14.900N  92.900W   33 390MB    0   3.00
CGS-B  09 02 66 00 55 18.5 14.500N  93.000W   28 520MB    0   5.11
CGS-B  09 02 66 06 22 44.6 12.700N  87.800W   98 440MB    0   3.79
CGS-B  10 02 66 23 31 26.5 14.500N  92.800W   33 440MB    0   3.79
CGS-B  12 02 66 08 36 36.3 16.100N  91.700W  167 390MB    0   3.00
CGS-B  15 02 66 00 16 53.7 14.500N  91.500W   71 440MB    0   3.79
CGS-B  15 02 66 14 54 42.9 14.500N  91.100W  137 390MB    0   3.00
CGS-B  17 02 66 01 24 13.9 14.300N  92.800W   19 370MB    0   3.00
CGS-B  26 02 66 07 54 35.5 13.300N  92.200W  152 490MB    0   4.62
CGS-B  27 02 66 05 39 38.5 14.100N  91.200W  129 400MB    0   3.12
CGS-B  27 02 66 11 49 10.9 14.300N  92.000W   33 430MB    0   3.62
CGS-B  07 03 66 09 10 53.9 14.600N  93.100W   17 500MB    0   4.78
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CGS-B   12 03 67 06 16 54.5 14.148N  93.061W  35 390MB         0      3.00    CGS-B   21 10 66 10 33 25.2 14.100N  91.100W  56 470MB         0      4.28
CGS-B   13 03 67 08 37 11.7 13.726N  88.069W  82 380MB         0      3.00    CGS-B   21 10 66 10 36 16.0 13.700N  91.200W  69 480MB         0      4.45
CGS-B   20 03 67 08 42 06.0 13.433N  90.048W   8 370MB         0      3.00    CGS-B   23 10 66 00 48 55.2 13.000N  92.100W  61 400MB         0      3.12
CGS-B   21 03 67 09 55 19.9 13.924N  90.955W 112 400MB         0      3.12    CGS-B   23 10 66 22 32 40.6 12.800N  91.400W  33 390MB         0      3.00
CGS-B   22 03 67 09 15 29.2 12.853N  87.823W  70 440MB         0      3.79    CGS-B   26 10 66 05 55 51.4 13.600N  91.100W  18 400MB         0      3.12
CGS-B   30 03 67 05 30 44.3 13.873N  89.532W  33 400MB         0      3.12    CGS-B   26 10 66 20 43 15.8 13.200N  90.600W  20 440MB         0      3.79
CGS-B   02 04 67 11 58 32.4 14.735N  92.951W  89 450MB         0      3.95    CGS-B   26 10 66 21 07 42.5 13.600N  91.300W  40 430MB         0      3.62
CGS-B   09 04 67 05 28 16.1 13.059N  89.243W  69 410MB         0      3.29    CGS-B   28 10 66 18 41 05.7 14.600N  93.200W  23 450MB         0      3.95
CGS-B   10 04 67 20 41 49.5 14.041N  93.435W  37 420MB         0      3.45    CGS-B   29 10 66 14 21 50.7 12.900N  89.300W  68 410MB         0      3.29
CGS-B   13 04 67 06 10 00.9 12.778N  89.141W  84 440MB         0      3.79    CGS-B   02 11 66 18 51 18.0 14.100N  91.900W  33 410MB         0      3.29
CGS-B   14 04 67 04 25 10.4 14.217N  91.772W  99 410MB         0      3.29    CGS-B   04 11 66 06 05 19.2 14.700N  93.300W  33 470MB         0      4.28
CGS-B   14 04 67 09 52 32.9 13.801N  93.092W  57 440MB         0      3.79    CGS-B   04 11 66 06 49 26.0 14.700N  93.300W  33 410MB         0      3.29
CGS-B   15 04 67 22 10 08.8 12.743N  88.163W  33 430MB         0      3.62    CGS-B   04 11 66 06 36 38.9 14.700N  93.300W  33 480MB         0      4.45
CGS-B   17 04 67 04 27 48.6 13.196N  90.023W 205 450MB         0      3.95    CGS-B   04 11 66 07 13 05.0 13.000N  93.200W  49 390MB         0      3.00
CGS-B   18 04 67 13 05 15.6 12.765N  87.943W  84 390MB         0      3.00    CGS-B   04 11 66 08 21 15.0 14.700N  92.700W  33 430MB         0      3.62
CGS-B   18 04 67 16 18 28.9 13.543N  92.402W  33 440MB         0      3.79    CGS-B   05 11 66 07 08 33.0 14.500N  93.200W  33 380MB         0      3.00
CGS-B   30 04 67 03 10 49.4 12.052N  86.852W 115 420MB         0      3.45    CGS-B   13 11 66 06 04 09.0 13.500N  89.600W  69 460MB         0      4.12
CGS-B   30 04 67 16 28 14.6 14.138N  91.387W  15 480MB         0      4.45    CGS-B   03 12 66 04 33 41.7 13.900N  93.300W  89 380MB         0      3.00
CGS-B   04 05 67 04 00 17.1 13.524N  93.194W  48 390MB         0      3.00    CGS-B   05 12 66 13 00 31.0 13.900N  91.400W  42 410MB         0      3.29
CGS-B   06 05 67 12 39 45.6 13.007N  92.398W 144 430MB         0      3.62    CGS-B   05 12 66 16 11 27.2 14.400N  90.500W  53 420MB         0      3.45
CGS-B   08 05 67 00 59 51.0 13.599N  91.296W 100 370MB         0      3.00    CGS-B   10 12 66 13 06 32.0 14.500N  92.000W  60 560MB         0      5.78
CGS-B   08 05 67 14 40 08.3 12.974N  88.073W  33 460MB         0      4.12    CGS-B   10 12 66 14 56 27.9 14.100N  92.000W  33 390MB         0      3.00
CGS-B   09 05 67 17 18 10.2 13.281N  93.014W  98 370MB         0      3.00    CGS-B   10 12 66 14 10 22.9 14.300N  92.300W  37 420MB         0      3.45
CGS-B   16 05 67 12 58 09.2 13.460N  90.639W  92 480MB   5.70UPL      5.70    CGS-B   10 12 66 15 16 07.5 14.600N  92.000W  33 380MB         0      3.00
CGS-B   16 05 67 15 11 28.5 13.275N  90.939W  75 410MB         0      3.29    CGS-B   11 12 66 06 59 32.6 14.100N  92.400W  31 450MB         0      3.95
CGS-B   19 05 67 07 52 03.9 13.241N  89.518W  89 510MB         0      4.95    CGS-B   12 12 66 12 35 30.5 14.500N  91.000W  52 390MB         0      3.00
CGS-B   20 05 67 07 48 53.0 13.540N  90.555W  89 470MB         0      4.28    CGS-B   12 12 66 13 52 38.1 14.000N  92.900W  33 390MB         0      3.00
CGS-B   20 05 67 07 58 15.3 14.001N  90.420W  94 410MB         0      3.29    CGS-B   13 12 66 05 17 29.4 13.500N  93.200W  42 380MB         0      3.00
NOS-B   20 05 67 21 38 12.1 12.594N  91.322W  33 400MB         0      3.12    CGS-B   13 12 66 09 53 30.2 14.100N  92.300W  34 460MB         0      4.12
CGS-B   21 05 67 03 12 01.0 13.283N  89.694W  71 450MB         0      3.95    CGS-B   13 12 66 11 51 38.6 14.700N  92.500W  33 380MB         0      3.00
CGS-B   21 05 67 05 42 06.2 13.844N  89.614W  62 430MB         0      3.62    CGS-B   14 12 66 06 52 34.2 14.400N  92.300W  23 440MB         0      3.79
CGS-B   23 05 67 11 37 16.8 13.889N  90.528W  76 380MB         0      3.00    CGS-B   23 12 66 02 02 19.6 12.900N  88.600W  88 450MB         0      3.95
CGS-B   23 05 67 19 12 20.3 13.340N  90.721W  68 450MB         0      3.95    CGS-B   23 12 66 22 10 25.0 12.600N  87.700W  32 450MB         0      3.95
CGS-B   28 05 67 14 37 53.3 14.194N  90.872W  33 370MB         0      3.00    CGS-B   25 12 66 02 20 05.7 13.500N  90.800W  63 370MB         0      3.00
CGS-B   29 05 67 01 43 54.7 13.791N  89.686W 123 420MB         0      3.45    CGS-B   27 12 66 21 22 16.5 13.300N  88.800W  78 540MB         0      5.45
CGSPDE  17 06 67 17 43 55.2 14.100N  90.000W 103 480MB         0      4.45    CGS-B   03 01 67 17 11 20.3 13.346N  90.264W  51 430MB         0      3.62
CGSPDE  20 06 67 13 26 59.5 14.500N  93.500W  33 430MB         0      3.62    CGS-B   04 01 67 00 28 07.5 13.100N  88.625W  72 410MB         0      3.29
CGSPDE  21 06 67 03 08 43.3 14.800N  93.300W  20 410MB         0      3.29    CGS-B   09 01 67 22 31 22.1 13.138N  88.981W  78 410MB         0      3.29
CGSPDE  23 06 67 13 30 46.0 12.900N  87.800W  11 420MB         0      3.45    CGS-B   10 01 67 17 18 39.7 13.957N  91.094W  33 420MB         0      3.45
CGSPDE  24 06 67 07 51 46.5 14.300N  92.600W  91 460MB         0      4.12    CGS-B   14 01 67 15 58 11.2 13.929N  91.190W   5 430MB         0      3.62
CGSPDE  24 06 67 15 55 02.9 14.400N  93.400W  55 380MB         0      3.00    CGS-B   18 01 67 07 48 18.3 14.945N  91.893W  93 410MB         0      3.29
CGSPDE  08 07 67 08 45 31.7 14.300N  91.600W  33 400MB         0      3.12    CGS-B   19 01 67 02 19 23.1 12.551N  86.613W 200 450MB         0      3.95
CGSPDE  14 07 67 18 02 08.1 13.300N  88.800W 147 460MB         0      4.12    CGS-B   26 01 67 16 10 33.7 14.906N  92.965W  57 540MB   5.40BRK      5.40
CGSPDE  18 07 67 04 37 10.2 13.700N  91.400W  59 400MB         0      3.12    CGS-B   27 01 67 05 06 14.0 13.119N  92.939W  43 470MB         0      4.28
CGSPDE  15 08 67 02 56 30.2 14.700N  90.700W  45 450MB         0      3.95    CGS-B   28 01 67 13 43 01.3 14.503N  92.838W  34 450MB         0      3.95
CGSPDE  16 08 67 15 22 04.1 14.400N  93.200W  45 380MB         0      3.00    CGS-B   03 02 67 09 05 33.5 14.594N  93.486W   6 440MB         0      3.79
CGSPDE  17 08 67 17 34 33.8 14.400N  92.900W  33 410MB         0      3.29    CGS-B   05 02 67 05 24 21.0 13.232N  90.893W  33 430MB         0      3.62
CGSPDE  23 08 67 19 02 27.8 13.500N  92.000W 109 440MB         0      3.79    CGS-B   07 02 67 09 02 35.0 14.292N  92.240W  33 420MB         0      3.45
CGSPDE  27 08 67 06 32 13.2 14.200N  89.600W  65 430MB         0      3.62    CGS-B   10 02 67 22 32 31.6 14.159N  92.537W  77 400MB         0      3.12
CGSPDE  10 09 67 00 41 05.2 13.800N  92.300W  47 390MB         0      3.00    CGS-B   15 02 67 09 18 06.5 13.975N  93.307W  64 410MB         0      3.29
CGSPDE  10 09 67 15 51 42.3 13.200N  89.500W  69 380MB         0      3.00    CGS-B   17 02 67 13 09 41.1 14.607N  93.258W  41 370MB         0      3.00
CGSPDE  13 09 67 08 33 25.8 14.100N  92.300W  39 390MB         0      3.00    CGS-B   20 02 67 06 48 08.6 13.446N  91.803W 107 380MB         0      3.00
CGSPDE  15 09 67 23 26 32.5 13.900N  92.400W  44 430MB         0      3.62    CGS-B   24 02 67 09 16 41.8 13.437N  90.117W 135 430MB         0      3.62
CGSPDE  26 09 67 11 32 11.5 14.300N  91.700W  68 440MB         0      3.79    CGS-B   25 02 67 21 53 16.1 14.250N  93.234W  33 410MB         0      3.29
CGSPDE  26 09 67 12 14 34.9 13.000N  91.300W 122 400MB         0      3.12    CGS-B   27 02 67 03 15 19.2 13.086N  93.388W  33 360MB         0      3.00
CGSPDE  04 10 67 00 12 12.5 13.700N  88.600W  33 440MB         0      3.79    CGS-B   03 03 67 01 00 19.0 14.407N  92.164W  27 420MB         0      3.45
CGSPDE  04 10 67 09 00 06.5 14.100N  92.500W  41 450MB         0      3.95    CGS-B   03 03 67 19 39 46.3 13.078N  90.392W  65 400MB         0      3.12
CGSPDE  04 10 67 22 27 29.1 14.700N  92.300W  33 420MB         0      3.45    CGS-B   08 03 67 15 52 15.8 13.049N  88.127W  75 390MB         0      3.00
CGSPDE  08 10 67 21 29 02.5 13.300N  90.800W  53 420MB         0      3.45    CGS-B   08 03 67 23 07 02.8 13.101N  88.782W  76 420MB         0      3.45
CGSPDE  12 10 67 03 17 27.9 14.400N  90.400W 190 390MB         0      3.00    CGS-B   09 03 67 14 08 44.6 14.537N  91.473W 102 470MB         0      4.28
CGSPDE  25 10 67 15 36 20.7 14.300N  93.100W  61 450MB         0      3.95    CGS-B   11 03 67 16 39 57.2 14.572N  91.489W  27 370MB         0      3.00
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CGSPDE 10 09 68 23 13 47.0 14.305N  92.936W  72 500MB        0       4.78     CGSPDE 25 10 67 16 11 14.8 14.500N  92.900W  60 420MB        0       3.45
CGS 74 15 09 68 C4 32 04.2 13.456N  87.243W 164 390MB        0       3.00     CGSPDE C4 11 67 22 29 46.4 14.200N  89.700W  24 400MB        0       3.12
CGS 75 23 09 68 05 11 23.2 14.397N  93.129W  43 430MB        0       3.62     CGSPDE 06 11 67 18 49 26.2 13.500N  88.000W  33 430MB        0       3.62
CGS 80 23 C9 68 04 49 38.0 14.832N  92.900W  33 420MB        0       3.45     CGSPDE 15 11 67 22 02 35.1 14.500N  90.400W  26 460MB        0       4.12
CGS 77 25 09 68 22 15 03.9 13.501N  92.023W 155 420MB        0       3.45     CGSPDE 17 11 67 21 20 28.3 13.700N  93.500W  33 380MB        0       3.00
CGSPDE 25 09 68 10 38 38.4 13.871N  92.638W 138 570MB        0       5.94     CGSPDE 18 11 67 12 16 55.4 13.400N  89.100W  78 510MB        0       4.95
CGS 75 30 09 68 11 26 15.7 13.032N  89.626W  94 440MB        0       3.79     CGSPDE 18 11 67 12 26 09.4 13.300N  89.300W  70 470MB        0       4.28
CGS 76 30 09 68 03 50 51.9 13.327N  93.046W  80 450MB        0       3.95     CGSPDE 18 11 67 12 53 00.8 12.900N  89.700W  50 450MB        0       3.95
CGS 75 02 1C 68 02 45 58.1 14.207N  90.989W  99 450MB        0       3.95     CGSPDE 24 11 67 09 20 03.7 14.100N  91.100W  33 420MB        0       3.45
CGS 81 C9 1C 68 C3 09 38.7 14.477N  92.887W  33 440MB        0       3.79     CGSPDE 25 11 67 C4 13 42.8 14.100N  90.500W  96 420MB        0       3.45
CGS 79 14 1C 68 21 12 23.6 13.903N  89.719W  90 420MB        0       3.45     CGSPDE 25 11 67 13 54 24.5 14.300N  92.100W 108 420MB        0       3.45
CGS 77 16 10 68 C6 08 45.3 13.693N  88.250W  16 430MB        0       3.62     CGSPDE 26 11 67 15 14 54.3 13.100N  90.100W  58 440MB        0       3.79
CGS 80 22 10 68 06 42 01.5 13.208N  88.247W  64 470MB        0       4.28     CGSPDE 30 11 67 07 00 40.1 13.800N  91.900W 150 450MB        0       3.95
CGS 85 26 1C 68 14 31 02.0 13.349N  92.035W 199 410MB        0       3.29     CGSPDE 06 12 67 02 53 06.9 12.500N  87.200W  87 530MB        0       5.28
CGS 82 28 1C 68 21 51 10.1 14.473N  92.665W  67 460MB        0       4.12     CGSPDE 06 12 67 03 33 46.4 13.100N  92.500W  77 440MB        0       3.79
CGS 82 30 10 68 1C 51 50.8 13.418N  91.069W  64 410MB        0       3.29     CGSPDE 24 12 67 15 44 42.2 14.200N  92.200W  33 430MB        0       3.62
CGS 85 31 1C 68 00 18 11.7 14.307N  90.762W  81 400MB        0       3.12     CGSPDE 11 01 68 20 48 59.1 14.500N  89.900W 197 440MB        0       3.79
CGS 85 11 11 68 03 11 06.8 13.035N  92.790W  80 510MB        0       4.95     CGSPDE 14 01 68 18 56 40.8 14.400N  92.200W  33 420MB        0       3.45
CGS 89 21 11 68 01 15 17.5 13.821N  93.391W  61 390MB        0       3.00     CGSPDE 18 01 68 08 42 48.9 13.700N  92.700W 111 380MB        0       3.00
CGS 95 23 11 68 11 41 00.2 14.433N  92.212W 115 420MB        0       3.45     CGSPDE 21 01 68 23 44 46.1 13.500N  92.300W 166 500MB        0       4.78
CGS 90 25 11 68 18 37 58.8 13.871N  92.363W 105 460MB        0       4.12     CGSPDE 21 01 68 23 45 17.1 16.800N  92.300W  77 540MB        0       5.45
CGS 96 08 12 68 C3 12 29.1 13.924N  90.594W 116 410MB        0       3.29     CGSPDE 26 01 68 10 37 56.8 12.700N  88.800W  60 390MB        0       3.00
CGS 95 10 12 68 18 07 33.7 13.214N  89.597W  69 430MB        0       3.62     CGSPDE 28 C1 68 08 47 20.3 12.600N  87.900W  75 440MB        0       3.79
CGS101 15 12 68 06 59 27.8 13.424N  92.977W  75 360MB        0       3.00     CGSPDE C3 02 68 15 40 44.5 16.600N  93.500W 142 550MB        0       5.61
CGS 95 16 12 68 09 18 51.1 13.317N  90.077W 156 450MB        0       3.95     CGSPDE 08 02 68 06 53 28.1 16.800N  93.500W 100 410MB        0       3.29
CGS101 29 12 68 17 36 29.9 14.488N  92.404W  60 540MB  5.25BRK       5.25     CGSPDE 17 C3 68 12 35 48.2 14.400N  92.600W  25 460MB        0       4.12
CGS  1 03 01 69 11 19 13.6 14.476N  91.653W  89 500MB        0       4.78     CGSPDE 19 C3 68 20 15 33.2 14.700N  92.900W  43 470MB        0       4.28
CGS  5 11 01 69 06 04 23.4 13.386N  90.780W  73 380MB        0       3.00     CGSPDE 24 03 68 17 13 20.0 12.500N  86.500W  79 510MB        0       4.95
CGS  5 14 01 69 20 08 09.3 14.903N  91.231W 113 410MB        0       3.29     CGSPDE 25 03 68 13 48 22.5 14.100N  92.200W  38 410MB        0       3.29
CGS  8 21 01 69 14 48 47.2 13.326N  90.186W  79 410MB        0       3.29     CGSPDE 25 03 68 16 32 05.2 13.200N  92.000W  60 510MB        0       4.95
CGS 1C 24 01 69 05 41 44.4 17.242N  92.319W  55 380MB        0       3.00     CGSPDE 28 C3 68 01 C7 37.6 13.100N  92.100W 111 520MB        0       5.11
CGS 16 C8 02 69 04 56 59.7 13.624N  88.271W  33 430MB        0       3.62     CGSPDE 06 C4 68 C3 32 29.2 14.100N  91.500W  93 410MB        0       3.29
CGS 19 C9 03 69 C7 12 39.0 13.101N  88.528W  75 440MB        0       3.79     CGSPDE 18 C4 68 04 40 38.7 12.500N  88.600W  54 490MB        0       4.62
CGS 21 14 03 69 C8 47 16.3 12.916N  86.755W 178 560MB  5.80PAL       5.80     CGSPDE C1 C5 68 10 28 58.2 14.956N  93.509W  61 460MB        0       4.12
CGS 25 16 C3 69 C6 05 50.9 13.125N  91.942W  33 390MB        0       3.00     CGSPDE C6 C5 68 C5 41 26.0 13.218N  88.605W  78 380MB        0       3.00
CGS 23 20 C3 69 06 31 48.9 14.591N  91.740W  50 390MB        0       3.00     CGSPDE C6 05 68 14 37 49.6 14.541N  90.821W 123 510MB        0       4.95
CGS 27 28 03 69 08 19 30.2 16.112N  92.387W 140 440MB        0       3.79     CGSPDE 06 05 68 21 23 11.0 13.021N  87.734W  56 460MB        0       4.12
CGS 25 C1 04 69 21 19 53.6 12.577N  88.233W  71 490MB        0       4.62     CGSPDE 07 05 68 23 39 14.4 13.043N  89.703W  91 460MB        0       4.12
CGS 31 04 04 69 08 43 06.4 13.534N  88.981W 105 430MB        0       3.62     CGSPDE C9 05 68 18 03 09.9 16.238N  93.446W 101 510MB        0       4.95
CGS 26 08 C4 69 19 41 58.6 12.570N  88.340W  76 480MB        0       4.45     CGSPDE 14 05 68 20 44 38.0 13.389N  92.791W 160 460MB        0       4.12
CGS 29 21 04 69 02 19 07.1 14.098N  91.015W  82 550MB  6.00PAL       6.00     CGSPDE 02 C6 68 19 29 14.0 13.913N  93.252W 100 450MB        0       3.95
CGS 29 22 04 69 00 29 25.0 14.078N  90.964W  89 480MB        0       4.45     CGSPDE C9 06 68 10 21 35.9 14.623N  91.980W  60 500MB        0       4.78
CGS 33 22 04 69 12 51 09.1 14.601N  91.658W  79 410MB        0       3.29     CGSPDE 11 06 68 05 52 33.5 13.941N  88.761W 199 530MB        C       5.28
CGS 31 25 04 69 16 46 31.5 13.311N  89.174W  70 430MB        0       3.62     CGSPDE 15 06 68 C5 11 17.2 14.446N  92.871W  25 540MB        0       5.20
CGS 34 02 05 69 01 21 17.8 13.268N  92.386W  33 400MB        0       3.12     CGSPDE 15 06 68 10 43 22.0 13.273N  92.826W  33 400MB        0       3.12
CGS 33 03 C5 69 C3 19 06.3 12.937N  88.449W  77 450MB        0       3.95     CGSPDE 17 06 68 C7 56 56.2 14.391N  92.894W  33 490MB        0       4.62
CGS 36 C9 05 69 1C 09 01.3 14.347N  91.562W  33 380MB        0       3.00     CGSPDE 21 C6 68 01 24 53.9 13.378N  92.091W 115 450MB        0       3.95
CGS 37 C9 C5 69 1C 47 56.8 12.689N  89.190W  68 410MB        0       3.29     CGSPDE 23 06 68 06 24 52.0 14.310N  92.253W 157 380MB        0       3.00
CGS 40 23 05 69 C9 18 05.1 13.385N  89.8C8W  94 420MB        0       3.45     CGSPDE 29 06 68 06 21 48.1 13.307N  90.220W  97 470MB        0       4.28
CGS 38 29 05 69 2C 25 56.2 14.722N  90.595W 218 480MB        0       4.45     CGSPDE C4 07 68 00 55 41.0 14.303N  92.432W  66 420MB        0       3.45
CGS 41 15 06 69 19 29 45.9 12.665N  90.135W 128 430MB        C       3.62     CGSPDE 07 07 68 19 49 36.0 14.078N  88.939W 134 450MB        0       3.95
CGS 45 23 06 69 02 38 57.3 13.177N  92.369W 112 400MB        0       3.12     CGSPDE 14 07 68 03 55 24.9 13.237N  88.843W  14 450MB        0       3.95
CGS 43 27 C6 69 13 20 09.5 13.321N  89.529W  63 430MB        0       3.62     CGSPDE 21 07 68 00 23 40.4 14.363N  93.061W  37 500MB        0       4.40
CGS 45 28 C6 69 04 34 42.6 12.818N  89.217W  69 520MB  5.13BRK       5.13     CGSPDE 26 07 68 06 33 59.6 14.395N  93.049W  14 490MB        0       5.70
CGS 44 02 07 69 05 18 20.0 13.972N  91.178W  61 420MB        0       3.45     CGSPDE 03 08 68 23 12 38.2 14.197N  92.188W  67 380MB        0       3.00
CGS 44 03 07 69 05 38 13.8 14.765N  92.495W  34 400MB        0       3.12     CGSPDE 05 08 68 16 41 22.9 17.250N  92.251W  33 460MB        0       4.12
CGS 43 07 07 69 C4 20 29.5 13.082N  89.014W  64 440MB        0       3.79     CGSPDE 06 08 68 03 24 04.3 17.220N  92.575W  13 440MB        0       3.79
CGS 51 17 07 69 13 24 22.9 12.590N  87.006W 175 440MB        0       3.79     CGSPDE 07 08 68 C5 17 08.3 12.335N  89.720W  37 42CMB        0       3.45
CGS 5C 19 C7 69 19 48 50.3 14.395N  92.652W 100 480MB        0       4.45     CGSPDE 2C 08 68 00 34 04.0 13.105N  87.833W 157 430MB        0       3.62
CGS 48 21 C7 69 09 05 38.1 13.137N  92.093W 175 470MB        0       4.28     CGSPDE 24 08 68 08 21 07.2 14.330N  92.195W 109 390MB        0       3.00
CGS 50 22 07 69 15 51 46.5 14.152N  91.476W 151 470MB        0       4.28     CGSPDE 02 09 68 C4 53 14.1 13.108N  90.365W  33 410MB        0       3.29
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CGS 31 30 04 70 09 06 57.0 14.339N  93.120W   20 460MB      0       4.12
CGS 31 30 04 70 12 51 36.3 14.447N  93.430W   24 530MB      0       5.60
CGS 31 30 04 70 13 21 03.2 14.476N  93.498W   22 540MB      0       5.60
CGS 31 30 04 70 21 53 10.5 14.385N  93.561W   42 470MB      0       4.28
CGS 32 30 04 70 00 54 13.6 14.437N  93.050W   57 490MB      0       4.62
CGS 32 30 04 70 03 59 50.2 14.332N  93.044W   33 510MB      0       4.80
CGS 32 30 04 70 08 59 07.5 14.331N  93.400W   33 520MB      0       5.11
CGS 32 30 04 70 13 10 23.8 14.407N  92.983W   33 450MB      0       3.95
CGS 32 30 04 70 15 45 12.4 13.935N  92.873W   33 450MB      0       3.95
CGS 32 30 04 70 21 56 27.3 14.710N  93.389W   33 480MB      0       4.45
CGS 32 30 04 70 21 12 06.0 14.374N  93.597W   19 470MB      0       4.28
CGS 34 30 04 70 03 58 24.3 14.306N  93.170W   33 450MB      0       3.95
CGS 34 30 04 70 11 37 18.7 14.329N  92.593W   33 470MB      0       4.28
CGS 35 30 04 70 09 13 58.1 14.327N  93.277W   33 450MB      0       3.95
CGS 35 30 04 70 18 21 44.1 14.621N  93.564W   21 480MB      0       4.45
CGS 35 30 04 70 23 43 43.2 14.430N  93.592W   33 440MB      0       3.79
CGS 32 01 05 70 04 08 07.2 14.311N  93.554W   35 510MB      0       4.95
CGS 32 01 05 70 08 23 03.4 14.314N  93.586W   49 500MB      0       4.78
CGS 32 01 05 70 11 02 25.4 14.336N  93.381W   33 450MB      0       3.95
CGS 33 01 05 70 11 31 34.3 14.394N  92.908W   68 400MB      0       3.12
CGS 33 01 05 70 17 24 18.2 14.140N  92.914W   45 460MB      0       4.12
CGS 33 01 05 70 22 41 02.2 14.712N  93.400W   29 440MB      0       3.79
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CGS 34 02 05 70 05 15 43.7 14.338N  92.962W   33 510MB      0       5.00
CGS 36 02 05 70 05 23 49.7 13.993N  93.051W   33 460MB      0       4.12
CGS 36 02 05 70 09 02 30.5 14.124N  93.398W   33 440MB      0       3.79
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CGS 32 04 05 70 06 59 30.1 14.525N  93.347W   33 460MB      0       4.12
CGS 36 04 05 70 11 24 14.0 13.995N  93.463W   40 380MB      0       3.00
CGS 34 07 05 70 18 44 18.5 14.979N  93.536W   50 470MB      0       4.28
CGS 36 08 05 70 00 10 45.7 14.913N  93.158W   33 410MB      0       3.29
CGS 37 12 05 70 22 36 16.4 14.130N  92.770W   33 430MB      0       3.62
CGS 33 15 05 70 09 44 45.2 14.312N  92.811W   33 540MB      0       5.50
CGS 35 15 05 70 07 44 18.5 14.387N  92.961W   64 470MB      0       4.28
CGS 33 17 05 70 19 09 32.0 14.367N  92.815W   33 480MB      0       4.45
CGS 36 17 05 70 10 29 12.3 14.078N  93.008W   23 470MB      0       4.28
CGS 33 19 05 70 00 57 11.8 14.314N  93.242W   33 460MB      0       4.12
CGS J1 20 05 70 04 13 04.0 14.418N  93.217W   60 480MB      0       4.45
CGS 40 21 05 70 15 46 28.2 14.355N  92.789W   62 460MB      0       4.12
CGS 37 23 05 70 16 16 43.3 14.912N  92.227W  109 490MB      0       4.62
CGS 39 23 05 70 23 10 57.0 14.185N  92.957W   54 460MB      0       4.12
CGS 37 25 05 70 04 56 58.5 13.673N  89.319W   35 410MB      0       3.29
CGS 39 01 06 70 06 04 49.8 14.381N  93.328W   55 470MB      0       4.28
CGS 39 01 06 70 18 18 35.0 14.372N  93.521W   33 460MB      0       4.12
CGS 42 05 06 70 09 25 42.9 14.244N  92.249W  102 460MB      0       4.12
CGS 44 07 06 70 04 53 39.6 13.082N  91.176W   62 420MB      0       3.45
CGS 41 11 06 70 09 26 02.1 13.645N  92.770W   92 490MB      0       4.62
CGS 44 16 06 70 01 56 34.9 13.341N  90.678W   87 460MB      0       4.12
CGS 44 27 06 70 22 53 27.0 14.395N  92.837W   41 530MB      0       5.10
CGS 46 01 07 70 19 12 32.3 14.085N  93.122W   37 460MB      0       4.12
CGS 48 05 07 70 05 42 05.0 12.331N  87.446W   33 450MB      0       3.95
CGS 52 24 07 70 21 02 32.6 13.329N  92.684W   85 420MB      0       3.45
CGS 51 02 08 70 17 53 55.4 14.149N  92.739W   33 410MB      0       3.29
CGS 55 09 08 70 22 29 50.0 14.719N  92.879W   33 430MB      0       3.62
CGS 61 28 08 70 02 31 21.1 13.677N  93.567W  100 430MB      0       3.62
CGS 63 01 09 70 01 03 41.2 13.077N  89.350W   80 420MB      0       3.45
CGS 62 06 09 70 20 44 49.7 12.733N  88.595W   75 450MB      0       3.95
CGS 64 13 09 70 13 42 52.7 14.037N  91.542W   70 420MB      0       3.45
CGS 70 23 09 70 22 55 00.1 13.321N  90.078W   83 460MB      0       4.12
CGS 71 23 09 70 22 48 33.8 13.314N  90.086W   80 470MB      0       4.28

CGS 48 26 07 69 07 21 00.2 12.325N  87.798W   84 480MB      0       4.45
CGS 55 03 08 69 21 17 16.9 13.342N  88.342W   52 430MB      0       3.62
CGS 54 09 08 69 01 19 04.2 13.202N  90.892W   33 400MB      0       3.12
CGS 63 23 08 69 16 41 29.8 13.930N  92.820W   65 400MB      0       3.12
CGS 60 29 08 69 13 53 08.5 14.465N  90.989W  118 430MB      0       3.62
CGS 59 04 09 69 06 25 28.1 13.216N  88.429W   53 460MB      0       4.12
CGS 70 16 09 69 14 25 42.3 13.455N  93.123W  104 500MB      0       4.78
CGS 64 24 09 69 11 40 53.3 13.184N  90.934W   63 430MB      0       3.62
CGS 69 05 10 69 20 35 35.5 13.345N  93.335W   73 420MB      0       3.45
CGS 68 09 10 69 09 06 02.7 13.301N  89.778W   67 430MB      0       3.62
CGS 65 10 10 69 04 06 24.1 13.199N  89.717W   71 460MB      0       4.12
CGS 68 10 10 69 02 32 56.0 13.467N  89.751W   65 410MB      0       3.29
CGS 66 12 10 69 22 48 15.2 13.211N  90.587W   68 400MB      0       3.12
CGS 66 15 10 69 11 54 13.9 14.320N  90.994W  105 440MB      0       3.79
CGS 71 27 10 69 10 23 29.5 14.429N  92.309W   96 430MB      0       3.62
CGS 72 06 11 69 13 13 56.5 13.735N  93.507W  114 460MB      0       4.12
CGS 72 06 11 69 13 01 20.1 13.030N  92.494W  141 500MB      0       4.78
CGS 73 12 11 69 03 48 28.2 13.688N  89.984W  111 400MB      0       3.12
CGS 77 15 11 69 15 40 21.3 14.375N  90.405W  121 390MB      0       3.00
CGS 74 16 11 69 10 30 01.7 13.331N  89.650W   79 490MB   4.88GOL    4.88
CGS 77 18 11 69 13 52 40.2 14.321N  92.871W  160 480MB      0       4.45
CGS M6 27 11 69 01 39 13.2 14.252N  93.169W   46 470MB      0       4.28
CGS  7 08 01 70 16 18 55.5 13.335N  90.507W   25 440MB      0       3.79
CGS  3 10 01 70 05 37 54.5 13.331N  92.311W   33 440MB      0       3.79
CGS 12 18 01 70 23 43 10.5 14.135N  90.929W  106 430MB      0       3.62
CGS  7 22 01 70 15 14 28.5 14.341N  92.406W   58 550MB   5.13GDL    5.13
CGS  8 28 01 70 04 47 05.2 14.139N  91.597W   92 500MB      0       4.78
CGS 11 31 01 70 22 23 37.1 13.727N  88.750W   46 500MB      0       4.50
CGS 13 08 02 70 16 19 20.7 14.370N  90.237W   33 460MB      0       4.12
CGS 13 15 02 70 07 00 54.0 12.861N  90.219W   70 450MB      0       3.95
CGS 16 21 02 70 10 14 16.8 13.806N  92.660W   45 460MB      0       4.12
CGS 29 20 03 70 10 44 49.9 13.328N  93.026W   41 430MB      0       3.62
CGS 30 20 03 70 13 36 03.2 14.418N  92.900W   33 420MB      0       3.45
CGS 25 24 03 70 08 24 45.9 14.443N  90.324W  197 420MB      0       3.45
CGS 22 27 03 70 18 39 18.9 12.031N  86.823W  182 510MB      0       4.95
CGS 25 09 04 70 16 24 31.0 13.212N  92.259W   41 530MB   5.75PAL    5.00
CGS 30 17 04 70 16 20 06.3 14.533N  93.119W   33 460MB      0       5.10
CGS 34 21 04 70 05 37 08.8 12.947N  87.880W   79 520MB      0       5.11
CGS 29 29 04 70 11 42 38.4 14.429N  92.635W   33 500MB      0       4.78
CGS 29 29 04 70 11 22 36.4 14.318N  92.690W   41 560MB   6.00PAL    6.30
CGS 29 29 04 70 12 29 19.3 14.327N  92.645W   33 450MB      0       3.95
CGS 29 29 04 70 12 52 52.6 14.437N  92.778W   33 450MB      0       3.95
CGS 30 29 04 70 14 01 32.8 14.318N  92.603W   33 580MB   7.00PAL    7.30
CGS 30 29 04 70 14 01 19.1 14.377N  92.751W   33 560MB      0       5.78
CGS 30 29 04 70 16 56 26.4 14.632N  92.697W   33 510MB      0       4.95
CGS 30 29 04 70 20 33 39.9 14.317N  92.686W   33 490MB      0       4.62
CGS 31 29 04 70 17 03 48.5 14.339N  92.872W   33 480MB      0       4.45
CGS 32 29 04 70 12 07 30.7 14.231N  92.811W   33 510MB      0       4.95
CGS 32 29 04 70 16 54 31.8 14.546N  92.743W   33 450MB      0       3.95
CGS 32 29 04 70 17 17 15.1 14.309N  92.868W   57 510MB      0       4.95
CGS 32 29 04 70 18 41 29.2 14.315N  93.031W   33 490MB      0       4.62
CGS 32 29 04 70 19 38 32.3 14.361N  93.552W   33 490MB      0       4.62
CGS 32 29 04 70 19 29 52.3 14.371N  93.499W   29 520MB      0       5.11
CGS 32 29 04 70 21 49 00.7 14.185N  93.380W   33 510MB      0       4.95
CGS 32 29 04 70 21 20 24.1 14.306N  93.570W   35 530MB      0       5.40
CGS 33 29 04 70 11 46 34.1 14.741N  92.594W   33 460MB      0       4.12
CGS 34 29 04 70 14 51 54.9 14.383N  93.094W   33 510MB      0       4.95
CGS 34 29 04 70 20 47 47.5 14.446N  92.866W   33 460MB      0       4.12
CGS 35 29 04 70 16 25 49.5 14.714N  92.493W   33 440MB      0       3.79
CGS 31 30 04 70 05 45 22.6 14.431N  93.330W   33 490MB      0       4.62
CGS 31 30 04 70 08 32 59.1 14.398N  93.192W   19 560MB   6.20PAL    6.40
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ERL 10 15 01 72 19 21 20.8 13.958N  90.988W  33 470MB     0      4.28   CGS 68 04 10 70 13 28 39.8 12.367N  90.318W  33 420MB     0      3.45
ERL  5 22 01 72 22 52 14.1 13.896N  91.064W 106 450MB     0      3.95   CGS 68 06 10 70 15 18 54.9 13.361N  88.312W 192 460MB     0      4.12
ERL  7 22 01 72 13 08 50.3 14.029N  91.014W 102 550MB  6.00PAL   6.00   CGS 68 10 10 70 06 44 02.4 14.346N  92.719W  51 450MB     0      3.95
ERL 12 23 01 72 11 11 43.1 13.613N  93.381W  87 450MB     0      4.12   CGS 70 13 10 70 23 21 42.5 13.764N  90.046W 100 480MB     0      4.45
ERL 10 30 01 72 14 59 40.9 14.497N  92.816W  33 450MB     0      3.95   CGS 71 24 10 70 11 45 58.9 14.384N  93.470W  54 440MB     0      3.79
ERL 10 30 01 72 14 59 42.1 14.541N  92.750W  43 450MB     0      3.95   NOS 75 08 11 70 11 49 36.0 13.333N  90.665W  96 450MB     0      3.95
ERL  7 31 01 72 23 09 10.2 13.848N  91.301W  78 440MB     0      3.79   NOS 81 16 11 70 06 17 54.1 14.277N  90.188W 204 460MB     0      4.12
ERL 11 17 02 72 09 19 06.4 13.259N  88.691W  80 470MB     0      4.28   NOS 79 18 11 70 06 58 34.1 13.768N  91.390W  77 490MB     0      4.62
ERL 18 26 02 72 15 25 33.1 13.937N  91.022W  33 460MB     0      4.12   NOS 81 29 11 70 20 00 56.2 13.311N  92.749W 124 510MB     0      4.95
ERL 14 04 03 72 22 04 23.4 12.933N  88.743W  64 470MB     0      4.28   NOS 81 06 12 70 18 56 30.6 14.826N  91.967W 128 430MB     0      3.62
ERL 16 07 03 72 14 06 21.0 14.735N  93.558W  35 450MB     0      3.95   NOS 85 15 12 70 07 54 51.6 14.390N  93.055W  33 510MB     0      4.90
ERL 15 11 03 72 03 50 45.9 13.368N  90.042W  85 510MB  5.60BRK   5.60   NOS 85 15 12 70 10 53 19.3 14.436N  93.075W  33 480MB     0      4.45
ERL 17 11 03 72 01 41 33.1 13.203N  89.825W 157 390MB     0      3.00   NOS 85 15 12 70 10 32 59.0 14.347N  93.133W  33 520MB     0      5.11
ERL 21 22 03 72 07 16 52.1 13.038N  90.948W  16 430MB     0      3.30   NOS 83 24 12 70 08 00 37.6 16.102N  93.554W 116 560MB  5.25BRK   5.25
ERL 26 29 03 72 15 08 20.0 14.417N  90.777W  82 420MB     0      3.45   NOS  9 03 02 71 14 48 41.8 14.362N  91.388W  95 490MB     0      4.62
ERL 22 09 04 72 15 26 59.9 13.528N  90.464W  85 480MB     0      4.45   NOS 15 18 02 71 09 20 20.1 14.458N  92.181W  79 490MB     0      4.62
ERL 24 11 04 72 07 33 52.8 13.523N  89.135W  93 450MB     0      3.95   NOS 16 19 02 71 06 27 58.2 14.151N  91.672W  68 500MB     0      4.78
ERL 26 12 04 72 16 59 12.6 14.121N  92.889W  33 450MB     0      3.60   NOS 16 19 02 71 16 59 40.3 13.362N  88.795W 176 520MB     0      5.11
ERL 27 17 04 72 19 25 59.7 13.514N  89.590W  88 430MB     0      3.62   NOS 16 20 02 71 12 24 58.3 14.318N  93.282W  34 500MB     0      4.40
ERL 32 30 04 72 10 55 19.5 12.896N  88.668W  77 440MB     0      3.79   NOS 23 26 02 71 02 00 10.0 12.333N  89.925W  71 400MB     0      3.12
ERL 32 04 05 72 06 26 40.5 13.990N  93.083W 115 510MB     0      4.95   NOS 26 14 03 71 03 59 49.7 14.142N  92.619W  68 400MB     0      3.12
ERL 32 23 05 72 00 37 45.2 13.141N  93.013W  96 460MB     0      4.12   NOS 23 24 03 71 16 18 29.6 14.125N  92.279W  54 500MB     0      4.78
ERL 37 05 06 72 06 22 36.7 13.336N  90.278W  33 470MB     0      4.28   NOS 23 25 03 71 05 14 52.9 14.103N  92.188W  63 420MB     0      3.45
ERL 35 07 06 72 23 09 04.4 14.490N  93.078W  54 460MB     0      4.12   NOS 29 14 04 71 03 09 09.1 14.125N  90.133W 124 480MB     0      4.45
ERL 35 07 06 72 23 17 30.1 14.368N  93.594W  38 410MB     0      3.29   NOS 30 19 04 71 05 07 48.5 13.907N  90.540W  92 500MB     0      4.78
ERL 34 11 06 72 18 21 16.7 13.403N  90.584W  52 510MB     0      4.95   NOS 31 01 05 71 14 32 12.8 13.259N  88.499W  93 540MB     0      5.45
ERL 35 11 06 72 19 09 11.6 13.511N  90.521W  79 440MB     0      3.79   NOS 32 03 05 71 08 09 49.6 16.336N  93.495W 149 430MB     0      3.62
ERL 39 13 06 72 19 44 35.3 14.446N  92.826W 127 440MB     0      3.79   NOS 39 19 05 71 13 15 43.1 14.311N  91.982W  86 470MB     0      4.28
ERL 39 22 06 72 13 13 13.0 13.831N  91.793W  84 450MB     0      3.95   NOS 38 23 05 71 08 23 41.3 16.264N  92.861W 130 470MB     0      4.28
ERL 38 25 06 72 01 52 25.9 12.068N  89.062W  65 440MB     0      3.79   NOS 37 25 05 71 22 11 12.9 14.063N  92.127W  45 490MB     0      4.62
ERL 36 27 06 72 19 39 36.1 13.981N  91.754W  74 510MB     0      4.95   NOS 36 28 05 71 14 12 07.9 14.634N  91.405W 124 540MB     0      5.45
ERL 40 30 06 72 03 56 28.6 14.048N  93.285W  33 500MB     0      3.70   NOS 37 28 05 71 03 09 04.1 13.049N  89.963W  86 430MB     0      3.62
ERL 41 30 06 72 12 45 20.2 14.542N  92.903W  33 490MB     0      4.10   NOS 39 28 05 71 20 19 25.7 13.732N  89.753W  84 440MB     0      3.79
ERL 38 01 07 72 00 32 48.5 14.011N  91.423W  47 440MB     0      3.79   NOS 41 29 05 71 00 00 53.5 13.363N  90.016W  72 450MB     0      3.95
ERL 39 05 07 72 13 00 18.5 13.951N  90.526W 109 480MB     0      4.45   NOS 41 11 06 71 11 51 40.1 12.647N  86.967W 148 450MB     0      3.95
ERL 42 27 07 72 20 44 20.4 13.276N  90.049W  77 450MB     0      3.95   NOS 44 13 06 71 03 54 26.8 14.234N  91.300W 104 430MB     0      3.62
ERL 42 27 07 72 21 16 44.6 13.210N  90.004W  91 450MB     0      3.95   ERL 47 28 06 71 02 44 07.7 14.445N  91.611W  97 500MB     0      4.78
ERL 44 27 07 72 20 03 52.9 13.317N  90.131W  78 450MB     0      3.95   ERL 56 06 08 71 19 52 47.6 14.298N  90.834W  87 460MB     0      4.12
ERL 45 28 07 72 13 53 40.1 13.151N  87.753W 209 440MB     0      3.79   ERL 60 12 08 71 05 59 00.1 12.677N  87.341W 211 470MB     0      4.28
ERL 43 06 08 72 23 06 20.6 13.478N  90.590W  83 460MB     0      4.12   ERL 66 20 08 71 21 36 09.6 13.376N  92.372W  33 580MB     0      5.60
ERL 49 11 08 72 10 54 49.8 16.180N  93.491W  98 450MB     0      3.95   ERL 64 22 08 71 11 01 59.0 13.759N  91.404W  69 480MB     0      4.45
ERL 50 21 08 72 23 33 50.0 13.957N  90.816W 119 480MB     0      4.45   ERL 68 06 09 71 09 58 48.2 13.921N  92.540W  60 510MB     0      4.95
ERL 51 30 08 72 00 13 27.7 14.706N  92.822W  27 430MB     0      3.62   ERL 69 07 09 71 08 02 33.5 13.622N  91.194W  74 380MB     0      3.00
ERL 51 31 08 72 02 24 09.6 13.272N  88.513W  50 540MB     0      4.80   ERL 70 12 09 71 05 32 03.4 14.112N  91.270W  33 430MB     0      3.62
ERL 57 30 09 72 11 15 23.0 14.356N  91.366W 119 440MB     0      3.79   ERL 70 18 09 71 17 11 54.7 13.326N  90.026W  82 480MB     0      4.45
ERL 57 05 10 72 10 48 19.1 13.839N  91.073W  89 540MB     0      5.45   ERL 77 24 09 71 08 28 43.6 13.991N  93.246W  33 440MB     0      3.79
ERL 66 17 11 72 14 55 45.2 13.614N  91.462W 222 520MB     0      5.11   ERL 80 30 09 71 13 33 34.9 14.718N  92.820W  33 480MB     0      4.45
ERL 66 19 11 72 04 35 24.1 12.973N  88.524W  73 560MB     0      5.78   ERL 77 12 10 71 09 44 59.3 13.844N  91.172W  36 570MB  6.00BRK   5.70
ERL 73 12 12 72 00 32 24.5 12.332N  89.048W  45 450MB     0      3.95   ERL 77 13 10 71 01 52 51.8 13.937N  91.144W  33 450MB     0      3.95
ERL 74 25 12 72 00 26 28.1 13.215N  88.943W  34 460MB     0      4.12   ERL 80 18 10 71 16 40 50.5 13.941N  91.138W  36 470MB     0      4.28
ERL  6 25 01 73 22 25 59.5 13.700N  89.324W 100 440MB     0      3.79   ERL 79 22 10 71 17 49 00.1 13.780N  91.239W  20 450MB     0      3.60
ERL 11 22 02 73 00 30 20.3 14.478N  91.637W 107 520MB     0      5.11   ERL 81 07 11 71 05 15 56.1 14.216N  91.857W  86 500MB     0      4.78
ERL 12 22 02 73 07 38 01.1 14.304N  90.977W 100 460MB     0      4.12   ERL 85 09 11 71 21 50 02.1 16.102N  93.205W 189 440MB     0      3.79
ERL 15 07 03 73 13 00 45.2 12.705N  88.027W  64 460MB     0      4.12   ERL 84 16 11 71 00 26 51.3 13.412N  90.729W 115 460MB     0      4.12
ERL 15 09 03 73 09 58 09.2 13.821N  91.266W 114 470MB     0      4.28   ERL 84 23 11 71 05 08 19.1 14.092N  92.542W  63 410MB     0      3.29
ERL 18 09 03 73 18 19 29.3 13.611N  90.687W  33 440MB     0      3.79   ERL 86 23 11 71 10 24 31.9 14.412N  90.171W 190 460MB     0      4.12
ERL 29 23 03 73 05 07 27.5 14.134N  91.086W 100 420MB     0      3.45   ERL 85 25 11 71 22 06 25.1 12.739N  87.458W  62 490MB     0      4.62
ERL 23 29 03 73 06 47 08.0 14.028N  90.226W  96 420MB     0      3.45   ERL 86 26 11 71 14 01 37.5 13.305N  89.140W  79 440MB     0      3.79
ERL 21 05 04 73 07 15 07.8 14.081N  92.197W  33 440MB     0      3.79   ERL 92 15 12 71 22 04 19.9 13.047N  91.088W 264 470MB     0      4.28
ERL 26 10 04 73 21 05 58.7 13.314N  91.453W  88 410MB     0      3.29   ERL 92 24 12 71 08 47 41.0 13.314N  92.123W 182 440MB     0      3.79
ERL 25 17 04 73 07 50 10.1 14.724N  93.568W  33 400MB     0      3.12   ERL  4 07 01 72 14 29 39.4 14.951N  91.942W  33 470MB     0      4.28
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CGSPDE 21 07 74 08 28 35.3 14.300N  92.100W  70 530MB      0    5.27   ERL 27 20 04 73 09 19 23.4 13.482N  90.028W  88 480MB      0       4.45
CGSPDE 21 07 74 11 43 52.5 14.300N  92.300W  33 480MB      0    4.44   ERL 28 27 04 73 04 58 06.0 13.416N  92.696W 126 470MB      0       4.28
CGSPDE 19 08 74 15 11 23.8 14.700N  93.500W  67 440MB      0    3.78   ERL 28 04 05 73 00 30 30.2 14.925N  91.161W 131 410MB      0       3.29
CGSPDE 26 08 74 06 27 40.7 16.000N  91.000W  33 510MB      0    4.94   ERL 33 24 05 73 19 34 13.5 14.710N  91.234W 100 520MB      0       5.11
CGSPDE 30 08 74 07 45 20.9 12.800N  87.400W  62 490MB      0    4.61   ERL 35 31 05 73 05 39 18.8 13.941N  90.877W  99 540MB   5.20BRK    5.20
CGSPDE 01 09 74 13 49 38.5 13.300N  88.900W 111 490MB      0    4.61   ERL 38 07 06 73 19 45 43.0 14.386N  91.951W  97 510MB      0       4.95
CGSPDE 02 09 74 22 04 31.5 13.200N  90.800W  41 450MB      0    3.95   ERL 39 07 06 73 18 32 42.9 14.277N  92.008W  78 550MB   6.20PAL    6.20
CGSPDE 03 09 74 12 46 54.1 14.200N  93.300W  33 430MB      0    3.62   ERL 42 07 06 73 18 34 46.3 14.183N  91.899W  70 570MB      0       5.94
CGSPDE 05 09 74 09 55 32.9 13.700N  91.700W  33 460MB      0    4.11   ERL 39 08 06 73 10 32 04.3 14.472N  92.052W  89 460MB      0       4.12
CGSPDE 12 09 74 20 14 37.3 13.000N  89.900W  85 500MB      0    4.77   ERL 41 08 06 73 05 37 15.5 14.007N  92.188W  77 420MB      0       3.45
CGSPDE 20 09 74 11 59 43.2 13.600N  91.100W  33 500MB      0    4.77   ERL 41 08 06 73 07 47 38.7 14.115N  91.857W  73 420MB      0       3.45
CGSPDE 12 10 74 05 32 39.6 14.300N  91.400W 105 410MB      0    3.29   ERL 38 09 06 73 00 58 04.0 14.070N  91.852W  76 470MB      0       4.28
CGSPDE 17 10 74 19 54 50.3 14.400N  91.100W 160 440MB      0    3.78   ERL 41 10 06 73 17 35 53.9 14.203N  91.402W  92 460MB      0       4.12
CGSPDE 17 10 74 23 09 19.9 13.300N  93.100W  20 460MB      0    4.11   ERL 45 15 06 73 08 02 23.6 13.040N  93.427W  75 450MB      0       3.95
CGSPDE 23 10 74 13 36 51.8 14.700N  90.600W 231 460MB      0    4.11   ERL 41 26 06 73 07 24 28.1 14.290N  90.706W  38 450MB      0       3.70
CGSPDE 25 10 74 00 05 34.1 13.600N  93.100W 120 550MB      0    5.60   ERL 40 30 06 73 08 08 57.6 13.753N  90.935W  78 510MB      0       4.95
CGSPDE 04 11 74 12 34 51.4 13.000N  90.100W  33 430MB      0    3.62   ERL 45 30 06 73 11 45 56.9 14.947N  93.202W 109 420MB      0       3.45
CGSPDE 04 11 74 21 23 24.0 12.700N  90.100W  33 470MB      0    4.28   ERL 43 05 07 73 19 16 18.8 13.653N  91.202W  48 430MB      0       3.62
CGSPDE 12 11 74 05 03 49.1 13.100N  91.300W  33 430MB      0    3.62   ERL 49 27 07 73 19 42 47.9 12.813N  86.674W 199 530MB      0       5.28
CGSPDE 02 12 74 12 36 44.5 14.000N  91.500W  97 520MB      0    5.10   ERL 47 31 07 73 03 44 43.4 13.323N  92.295W  24 410MB      0       3.29
CGSPDE 17 12 74 15 31 16.4 13.200N  88.500W  50 500MB      0    4.77   CGSPDE 19 08 73 22 17 49.4 12.700N  88.500W  68 510MB      0       4.94
CGSPDE 24 12 74 02 10 25.4 14.300N  90.100W 155 540MB      0    5.43   ERL 49 19 08 73 22 17 49.4 12.831N  88.507W  68 510MB      0       4.95
CGSPDE 28 12 74 23 49 51.0 13.000N  91.100W 186 460MB      0    4.11   CGSPDE 21 08 73 12 42 32.5 13.300N  90.600W  70 390MB      0       3.00
CGSPDE 31 12 74 20 21 09.0 14.130N  91.820W  39 570MB      0    5.93   GS  54 21 08 73 12 42 32.5 13.252N  90.564W  70 390MB      0       3.00
CGSPDE 31 12 74 20 15 32.7 14.100N  91.900W  75 540MB      0    5.43   CGSPDE 05 09 73 06 15 36.2 13.000N  90.600W  33 420MB      0       3.45
CGSPDE 31 12 74 21 56 10.0 14.200N  91.900W  75 490MB      0    4.61   CGSPDE 08 09 73 15 59 59.6 12.300N  89.800W  63 410MB      0       3.29
CGSPDE 01 01 75 02 12 44.7 13.400N  91.700W  33 430MB      0    3.62   CGSPDE 19 09 73 23 42 48.0 12.700N  88.000W  55 500MB      0       4.77
CGSPDE 01 01 75 11 54 29.2 13.200N  91.900W  33 400MB      0    3.12   CGSPDE 01 10 73 08 40 06.5 13.300N  89.800W  68 450MB      0       3.95
CGSPDE 01 01 75 22 52 36.4 14.100N  91.900W  80 500MB      0    4.77   CGSPDE 02 11 73 03 06 56.8 13.200N  88.000W 118 450MB      0       3.95
CGSPDE 01 01 75 23 41 22.0 14.200N  91.800W 108 440MB      0    3.78   CGSPDE 06 11 73 01 02 40.3 14.400N  91.400W 111 470MB      0       4.28
CGSPDE 07 01 75 21 10 14.8 13.400N  93.500W 139 450MB      0    3.95   CGSPDE 09 11 73 02 36 55.5 14.000N  89.600W 149 490MB      0       4.61
CGSPDE 09 01 75 06 12 47.4 14.000N  92.000W  59 460MB      0    4.11   CGSPDE 10 11 73 19 46 26.8 14.300N  90.200W 243 460MB      0       4.11
CGSPDE 09 01 75 15 20 26.1 13.200N  91.900W  33 440MB      0    3.78   CGSPDE 21 11 73 13 31 32.1 14.300N  92.700W  59 530MB      0       5.27
CGSPDE 11 01 75 18 07 44.4 14.300N  91.400W 104 460MB      0    4.11   CGSPDE 21 11 73 16 13 40.1 14.200N  92.600W  33 450MB      0       3.95
CGSPDE 21 01 75 00 36 11.3 14.400N  92.100W 106 440MB      0    3.78   CGSPDE 25 11 73 15 11 00.3 13.900N  92.700W  51 440MB      0       3.78
CGSPDE 01 02 75 09 36 44.9 13.100N  92.600W 237 430MB      0    3.62   CGSPDE 28 11 73 06 45 06.3 14.300N  90.000W 230 500MB      0       4.77
CGSPDE 03 02 75 01 03 25.2 13.600N  91.800W 218 540MB      0    5.43   CGSPDE 03 12 73 12 05 30.7 14.100N  92.000W  33 450MB      0       3.95
CGSPDE 10 02 75 03 59 06.9 13.100N  88.600W 179 460MB      0    4.11   CGSPDE 04 12 73 08 45 00.5 14.200N  91.900W  61 430MB      0       3.62
CGSPDE 14 02 75 09 16 38.1 14.711N  90.737W  11            0    3.10   CGSPDE 05 12 73 04 01 50.3 14.700N  91.800W 115 490MB      0       4.61
CGSPDE 20 02 75 03 23 54.6 14.300N  91.100W 143 460MB      0    4.11   CGSPDE 08 12 73 00 55 11.6 13.300N  89.900W  88 490MB      0       4.61
CGSPDE 24 02 75 14 19 42.1 14.800N  91.900W  33 460MB      0    4.11   CGSPDE 05 01 74 12 38 25.7 14.000N  92.500W  33 430MB      0       3.62
CGSPDE 01 03 75 12 37 32.6 12.600N  89.600W  33 440MB      0    3.78   CGSPDE 17 01 74 11 16 02.8 13.200N  88.300W 103 460MB      0       4.11
CGSPDE 13 03 75 23 40 10.9 16.300N  87.000W  33 520MB      0    5.10   CGSPDE 02 02 74 07 07 40.8 14.100N  92.000W  75 510MB      0       4.94
CGSPDE 14 03 75 06 04 31.3 13.600N  93.400W 155 550MB      0    5.60   CGSPDE 09 02 74 18 36 06.0 14.700N  91.900W 109 480MB      0       4.44
CGSPDE 24 03 75 06 59 56.5 13.800N  90.800W  59 490MB      0    4.61   CGSPDE 02 03 74 16 54 26.2 13.700N  91.700W  43 460MB      0       4.11
CGSPDE 24 03 75 07 15 32.3 13.100N  90.800W  33 450MB      0    3.95   CGSPDE 04 03 74 14 54 36.1 13.300N  90.600W  89 450MB      0       3.95
CGSPDE 24 03 75 11 51 03.9 13.000N  89.300W  93 460MB      0    4.11   CGSPDE 04 03 74 14 56 52.1 13.000N  90.600W  79 460MB      0       4.11
CGSPDE 25 03 75 02 31 22.2 13.000N  90.700W  33 520MB      0    5.10   CGSPDE 05 03 74 15 10 24.1 13.200N  90.800W  84 430MB      0       3.62
CGSPDE 29 03 75 09 30 19.6 12.900N  88.400W  33 450MB      0    3.95   CGSPDE 07 03 74 20 11 50.3 14.900N  91.500W 121 450MB      0       3.95
CGSPDE 04 04 75 14 36 57.4 14.400N  91.400W 143 420MB      0    3.45   CGSPDE 21 03 74 22 01 13.3 13.900N  90.100W  99 430MB      0       3.62
CGSPDE 14 04 75 23 17 43.1 13.800N  90.200W 107 430MB      0    3.62   CGSPDE 02 04 74 20 12 21.1 13.300N  90.300W  91 460MB      0       4.11
CGSPDE 23 04 75 15 03 51.9 13.700N  92.200W  33 460MB      0    4.11   CGSPDE 10 04 74 22 43 00.6 14.300N  91.600W 108 540MB      0       5.43
CGSPDE 01 05 75 11 50 03.0 13.200N  91.600W  33 440MB      0    3.78   CGSPDE 14 04 74 06 55 01.8 14.700N  91.300W 138 530MB      0       5.27
CGSPDE 21 05 75 16 41 57.8 13.300N  89.800W  33 460MB      0    4.11   CGSPDE 20 04 74 07 41 20.7 13.000N  90.000W  23 470MB      0       4.28
CGSPDE 22 05 75 12 51 11.9 12.700N  87.900W  33 500MB      0    4.77   CGSPDE 23 04 74 11 41 40.9 13.000N  91.700W 180 480MB      0       4.44
CGSPDE 04 06 75 19 36 21.5 12.700N  88.500W  33 460MB      0    4.11   CGSPDE 02 05 74 03 12 54.0 13.900N  90.700W  76 470MB      0       4.28
CGSPDE 07 06 75 16 07 01.1 14.400N  92.500W  33 450MB      0    3.95   CGSPDE 02 05 74 03 51 50.4 13.800N  90.500W  65 460MB      0       4.11
CGSPDE 19 06 75 16 12 42.2 13.400N  89.300W  93 500MB      0    4.77   CGSPDE 03 05 74 07 56 37.0 14.000N  92.100W  53 470MB      0       4.28
CGSPDE 26 06 75 06 45 17.8 14.000N  90.800W  76 480MB      0    4.44   CGSPDE 04 05 74 17 49 28.8 13.900N  90.500W 115 450MB      0       3.95
CGSPDE 12 07 75 16 20 35.0 14.400N  93.200W  33 440MB      0    3.78   CGSPDE 21 06 74 15 29 15.9 14.200N  90.000W  65 420MB      0       3.45
CGSPDE 13 08 75 23 07 43.5 14.300N  89.900W 256 470MB      0    4.28   CGSPDE 19 07 74 20 40 29.8 14.300N  92.300W  59 450MB      0       3.95
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CGSPDE 22 08 75 23 08 16.9 14.000N  93.500W  38 520MB    0   5.10
CGSPDE 31 08 75 13 19 03.7 14.100N  90.600W  88 450MB    0   3.95
CGSPDE 04 09 75 19 14 06.4 12.900N  90.700W  33 470MB    0   4.28
CGSPDE 12 09 75 08 56 58.8 13.500N  90.900W  43 430MB    0   3.62
CGSPDE 21 09 75 15 55 27.2 14.100N  91.000W 102 480MB    0   4.44
CGSPDE 30 09 75 15 35 24.4 14.500N  91.000W 107 480MB    0   4.44
CGSPDE 30 09 75 19 01 25.7 13.200N  91.500W 298 430MB    0   3.62
CGSPDE 06 10 75 06 54 19.2 13.800N  92.900W  23 440MB    0   3.78
CGSPDE 06 10 75 13 42 26.0 13.500N  92.900W  21 470MB    0   4.28
CGSPDE 15 10 75 20 55 50.9 15.453N  88.045W  33 470MB    0   4.28
CGSPDE 23 10 75 01 20 03.5 17.200N  93.300W  33 510MB    0   4.94
CGSPDE 05 11 75 17 04 21.4 15.900N  92.818W  12 500MB    0   4.77
CGSPDE 27 11 75 08 43 52.9 12.597N  87.368W 191 430MB    0   3.62
CGSPDE 15 12 75 14 27 57.8 14.370N  92.588W  77 500MB    0   4.77
CGSPDE 15 12 75 17 36 29.7 14.387N  92.691W  65 520MB    0   5.10
CGSPDE 10 01 76 10 54 55.7 14.205N  93.001W  38 440MB    0   3.78
CGSPDE 25 01 76 03 37 29.4 14.750N  91.872W 139 490MB    0   4.61
CGSPDE 25 01 76 10 59 48.4 13.932N  90.883W 103 500MB    0   4.77
CGSPDE 26 01 76 02 17 46.3 13.942N  91.005W  69 510MB    0   4.94
CGSPDE 26 01 76 07 28 43.3 13.592N  90.848W  33 480MB    0   4.44
CGSPDE 04 02 76 09 03 28.3 14.700N  90.600W   5 580MB    0   6.11
CGSPDE 04 02 76 09 01 42.4 15.270N  89.250W   5          0   7.50
CGSPDE 06 02 76 04 11 03.3 14.600N  91.100W   5 480MB    0   4.45
CGSPDE 06 02 76 18 19 17.7 14.700N  90.600W   5 580MB    0   6.11
CGSPDE 06 02 76 18 11 59.2 14.500N  90.200W   5 520MB    0   5.12
CGSPDE 08 02 76 08 13 51.9 15.700N  88.500W   5          0   5.70
CGSPDE 09 02 76 11 44 46.7 15.300N  89.100W   5 510MB    0   4.95
CGSPDE 10 02 76 06 17 43.0 15.000N  89.700W   5 470MB    0   4.29
CGSPDE 11 02 76 06 36 48.7 14.750N  91.126W   9          0   3.20
CGSPDE 11 02 76 09 32 20.4 14.808N  90.510W  10          0   3.10
CGSPDE 11 02 76 09 53 02.5 14.750N  90.980W   7          0   3.00
CGSPDE 11 02 76 10 51 03.9 14.757N  90.975W   7          0   3.00
CGSPDE 11 02 76 11 42 03.7 14.724N  90.998W   8          0   3.00
CGSPDE 11 02 76 16 36 23.0 14.790N  90.984W   7          0   3.00
CGSPDE 11 02 76 22 10 58.6 14.537N  90.680W   4          0   3.30
CGSPDE 12 02 76 02 15 04.6 14.594N  90.468W   6          0   3.30
CGSPDE 12 02 76 04 39 54.5 14.636N  90.668W   7          0   3.00
CGSPDE 12 02 76 07 02 02.4 14.859N  90.340W   8          0   3.30
CGSPDE 12 02 76 07 44 35.7 14.852N  90.619W  12          0   3.00
CGSPDE 12 02 76 10 57 35.5 14.714N  90.796W   9          0   3.20
CGSPDE 12 02 76 12 03 33.5 14.589N  90.625W  13          0   3.20
CGSPDE 12 02 76 22 50 34.0 14.750N  90.355W  11          0   3.00
CGSPDE 13 02 76 06 27 42.3 14.573N  90.483W  13          0   3.10
CGSPDE 13 02 76 07 01 32.5 14.584N  90.477W  13          0   3.20
CGSPDE 13 02 76 13 44 01.3 14.755N  90.987W   1          0   3.20
CGSPDE 14 02 76 03 15 59.8 14.959N  90.545W  10          0   3.20
CGSPDE 14 02 76 03 00 40.8 14.858N  90.636W  11          0   3.10
CGSPDE 14 02 76 19 12 53.2 14.643N  90.950W   4          0   3.80
CGSPDE 14 02 76 20 36 28.2 14.315N  90.583W  11          0   3.50
CGSPDE 14 02 76 20 44 04.7 14.743N  90.377W   6          0   3.10
CGSPDE 14 02 76 21 22 55.0 14.740N  91.007W  11          0   3.20
CGSPDE 15 02 76 00 34 43.7 14.776N  90.965W   6          0   3.40
CGSPDE 15 02 76 04 36 12.1 14.508N  90.551W   3          0   3.40
CGSPDE 15 02 76 10 53 24.1 14.720N  90.748W  10          0   3.20
CGSPDE 15 02 76 13 08 31.6 14.782N  90.980W   9          0   3.40
CGSPDE 15 02 76 20 19 59.9 14.792N  90.982W   4          0   3.20
CGSPDE 16 02 76 07 58 08.5 14.848N  90.678W  12          0   3.00
CGSPDE 16 02 76 09 11 46.8 14.750N  90.998W  10          0   3.10
CGSPDE 17 02 76 05 27 05.9 14.723N  90.801W  12          0   3.00
CGSPDE 17 02 76 15 49 25.3 14.791N  90.974W   2          0   3.00
CGSPDE 21 02 76 02 05 36.0 15.032N  89.452W   6          0   3.10
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CGSPDE 21 02 76 07 52 07.8 14.991N  89.627W  10          0   3.20
CGSPDE 21 02 76 13 03 53.0 14.971N  89.676W  11          0   3.00
CGSPDE 22 02 76 06 42 40.7 15.326N  88.520W   8          0   3.00
CGSPDE 22 02 76 12 09 58.3 15.275N  89.007W   6          0   3.70
CGSPDE 22 02 76 21 38 32.9 15.217N  89.003W  14          0   3.80
CGSPDE 24 02 76 08 21 49.2 15.600N  88.438W   2          0   3.20
CGSPDE 24 02 76 13 37 59.9 15.496N  88.599W  12          0   3.00
CGSPDE 25 02 76 01 28 48.3 14.977N  89.647W   6          0   3.30
CGSPDE 26 02 76 11 20 06.0 14.841N  89.641W   9          0   3.00
CGSPDE 27 02 76 01 20 58.2 15.380N  88.451W   9          0   3.10
CGSPDE 07 03 76 02 54 05.4 14.900N  90.900W   5 480MB    0   4.45
CGSPDE 07 03 76 03 15 40.3 14.700N  90.500W   5 490MB    0   4.62
CGSPDE 23 03 76 05 03 36.7 15.314N  88.906W   9          0   3.20
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EARTHQUAKE DATA SORTED BY SOURCES

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D S    D M Y H M S   L   L   D  M          M
A O    A O E O I E   A   O   E  B          A
T U    Y N A U N C   T   N   P             G
A R      T R R U O   I   G   T  M          N
  C      H     T N   T   I   H  A          I
  E            E D   U   T      G          T
                     D   U                 U
                     E   D                 D
                         E                 E

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****   S1 - MOTAGUA
CGSPDE 04 02 76 09 01 42.4 15.270N 89.250W    5                    7.50
CGSPDE 08 02 76 08 13 51.9 15.700N 88.500W    5                    5.70
CGSPDE 09 02 76 11 44 46.7 15.300N 89.100W    5 510MB              4.95
CGSPDE 10 02 76 06 17 43.0 15.600N 89.700W    5 470MB              4.29
CGSPDE 07 03 76 02 54 05.4 14.900N 90.900W    5 480MB              4.45
CGSPDE 11 02 76 09 53 02.5 14.760N 90.980W    7                    3.00
CGSPDE 11 02 76 10 51 03.9 14.767N 90.975W    7                    3.00
CGSPDE 11 02 76 11 42 03.7 14.724N 90.998W    8                    3.00
CGSPDE 11 02 76 16 36 23.0 14.790N 90.984W    7                    3.00
CGSPDE 12 02 76 07 02 02.4 14.839N 90.340W    8                    3.30
CGSPDE 12 02 76 10 57 35.5 14.714N 90.796W    9                    3.20
CGSPDE 12 02 76 22 50 34.0 14.750N 90.355W   11                    3.00
CGSPDE 13 02 76 06 27 42.3 14.573N 90.483W   13                    3.10
CGSPDE 13 02 76 07 01 32.5 14.684N 90.477W   13                    3.20
CGSPDE 13 02 76 13 44 01.3 14.735N 90.987W    1                    3.20
CGSPDE 14 02 76 03 00 40.8 14.858N 90.636W   11                    3.10
CGSPDE 14 02 75 09 16 38.1 14.711N 90.737W   11                    3.10
CGSPDE 14 02 76 19 12 53.2 14.543N 90.950W    4                    3.80
CGSPDE 14 02 76 20 44 04.7 14.743N 90.377W    6                    3.10
CGSPDE 14 02 76 21 22 55.0 14.740N 91.007W   11                    3.20
CGSPDE 15 02 76 00 34 43.7 14.776N 90.965W    6                    3.40
CGSPDE 15 02 76 10 53 24.1 14.720N 90.748W   10                    3.20
CGSPDE 15 02 76 13 08 31.6 14.782N 90.980W    9                    3.40
CGSPDE 15 02 76 20 19 59.9 14.792N 90.982W    4                    3.20
CGSPDE 16 02 76 09 11 46.8 14.750N 90.998W   10                    3.10
CGSPDE 17 02 76 05 27 05.9 14.723N 90.801W   12                    3.00
CGSPDE 17 02 76 15 49 25.5 14.791N 90.974W    2                    3.00
CGSPDE 21 02 76 02 05 36.0 15.052N 89.452W    6                    3.10
CGSPDE 21 02 76 07 52 07.8 14.991N 89.627W   10                    3.20
CGSPDE 21 02 76 13 03 53.0 14.971N 89.676W   11                    3.00
CGSPDE 22 02 76 06 42 40.7 15.026N 88.520W    8                    3.00
CGSPDE 22 02 76 12 09 58.5 15.275N 89.007W    6                    3.70
CGSPDE 22 02 76 21 38 32.9 15.217N 89.003W   14                    3.80
CGSPDE 23 03 76 05 03 36.7 15.514N 88.906W    9                    3.20
CGSPDE 24 02 76 08 21 49.2 15.650N 88.438W    2                    3.20
CGSPDE 24 02 76 13 37 59.9 15.496N 88.599W   12                    3.00
CGSPDE 25 02 75 01 28 48.5 14.977N 89.647W    6                    3.30
CGSPDE 26 02 76 11 20 06.0 14.841N 89.641W    9                    3.00
CGSPDE 27 02 76 01 20 58.2 15.580N 88.451W    9                    3.10
CGS-B  09 07 61 04 57 36.8 16.400N 87.800W   50   0        450PAS  4.50
GUTE   27 04 36 06 31 01.0 17.000N 87.000W    0   0        560PAS  5.60
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GUTE   27 04 36 06 31 01.0 17.000N 87.000W   0   0       560PAS   5.60
CGS-B  27 01 64 11 21 14.4 17.000N 87.000W  33 380MB       0      3.00
CGS-B  25 01 64 18 43 26.8 17.100N 87.200W  33 380MB       0      3.00
CGS-B  25 01 64 17 35 04.9 17.000N 86.900W  33 390MB       0      3.00
CGS-B  25 01 64 22 46 18.4 17.000N 86.600W  33 390MB       0      3.00
CGS-B  25 09 63 01 09 39.7 16.500N 87.100W  33 420MB       0      3.45
CGS-B  25 09 63 00 47 38.0 16.500N 86.600W  33 430MB       0      3.62
CGS-B  15 09 64 05 09 23.2 15.100N 91.000W  33 380MB       0      3.00
CGS-B  19 10 63 21 22 25.2 15.200N 89.200W  33 390MB       0      3.00
CGS-B  28 10 63 02 25 07.9 14.800N 90.800W  33 390MB       0      3.00
CGSPDE 15 08 67 02 56 30.2 14.700N 90.700W  45 450MB       0      3.95
SYKES  27 10 57 18 29 10.3 15.970N 88.110W  56   0       400PAL   4.00
CGS-B  05 08 65 19 05 07.7 14.800N 91.000W  59 400MB       0      3.12
GUTE   26 06 46 07 53 40.0 14.750N 90.750W  90   0       650PAS   6.50
CGSPDE 13 03 75 23 40 10.9 15.500N 87.000W  33 520MB              5.10

****   S2 - POLOCHIC
CGS-B  18 01 64 21 57 14.4 15.100N 89.300W  33 380MB       0      3.00
CGS    07 12 57 08 24 03.0 15.500N 92.000W   0   0       560TAC   5.60
CGS-B  26 10 66 20 43 15.8 15.200N 90.600W  20 440MB       0      3.79
CGS-B  15 09 64 07 51 28.8 15.400N 90.600W  33 390MB       0      3.00
CGS 37 25 05 70 04 56 58.5 15.673N 89.319W  35 410MB       0     *3.29
CGS-B  27 11 64 23 50 38.4 15.800N 89.400W  33 400MB       0      3.12
CGSPDE 04 10 67 00 12 12.5 15.700N 88.600W  33 440MB       0      3.79
CGSPDE 24 03 75 07 15 32.5 15.100N 90.800W  33 450MB              3.95
GUTE   17 08 32 08 46 53.0 15.500N 91.500W  40   0       560PAS   5.60
CGS    13 04 60 12 37 43.0 15.500N 92.000W  50   0      D600PAS   6.00
CGS-B  15 09 64 21 56 07.2 15.300N 90.800W  74 440MB       0      3.79
ERL 26 10 04 73 21 05 58.7 15.314N 91.453W  88 410MB       0    D*3.29
CGS    29 09 60 18 54 27.2 15.300N 90.000W  86   0       488PAL   4.88
CGS-B  20 02 67 06 48 08.6 15.446N 91.803W 107 380MB       0     *3.00
CGS-B  14 09 64 15 45 22.2 15.500N 90.800W  38 480MB       0      4.45
CGS  7 08 01 70 15 18 55.5 15.335N 90.507W  25 440MB       0     *3.79

****   S3 - VOLCANO
CGSPDE 06 02 76 04 11 03.3 14.500N 91.100W   5 480MB              4.45
CGSPDE 06 02 76 18 11 59.2 14.300N 90.200W   5 520MB              5.12
CGSPDE 11 02 76 06 36 48.7 14.750N 91.126W   9                    3.20
CGSPDE 12 02 76 02 15 04.8 14.694N 90.468W   6                    3.30
CGS    24 10 50 00 52 03.0 15.000N 92.000W   0   0       620PAS   6.20
CGS-B  27 12 63 03 57 09.8 14.500N 90.700W  33 390MB       0      3.00
CGS-B  15 07 63 16 32 18.5 14.400N 90.200W  33 380MB       0      3.00
CGSPDE 25 03 68 16 32 05.2 15.200N 92.000W  60 510MB       0      4.95
GUTE   12 06 12 12 43 42.0 17.000N 89.000W   0   0       680PAS   6.80
CGS 34 02 05 69 01 21 17.8 15.258N 92.386W  33 400MB       0     *3.12
CGS-B  08 07 66 01 12 04.7 15.000N 91.900W  33 370MB       0      3.00
ERL  4 07 01 72 14 29 39.4 14.961N 91.942W  33 470MB       0    N*4.28
CGS-B  29 08 65 01 26 07.5 14.800N 91.500W  33 390MB       0      3.00
CGS-B  18 08 66 19 40 52.2 14.900N 91.900W  33 370MB       0      3.00
CGS-B  01 06 66 02 52 05.9 14.700N 91.200W  26 360MB       0      3.00
CGS-B  13 03 64 21 08 12.1 14.500N 90.900W  33 480MB       0      4.45
ERL 41 26 06 73 07 24 28.1 14.290N 90.706W  38 450MB  F    0      3.70
CGSPDE 15 11 67 22 02 35.1 14.300N 90.400W  26 460MB       0      4.12
CGSPDE 04 11 67 22 29 46.4 14.200N 89.700W  24 400MB       0      3.12
CGS-B  12 12 66 12 35 30.6 14.500N 91.000W  52 390MB       0      3.00
CGS 23 20 03 69 06 31 48.9 14.591N 91.740W  50 390MB       0      3.00
GUTE   26 09 31 19 50 30.0 15.000N 92.000W  60   0       600PAS   6.00
CGS-B  23 10 66 00 48 55.2 15.000N 92.100W  61 400MB       0      3.12
CGS-B  08 09 66 06 43 14.5 14.700N 91.500W  62 350MB       0      3.00
CGS-B  21 05 67 05 42 06.2 15.644N 89.614W  62 430MB       0     *3.62
CGSPDE 21 06 74 15 29 15.9 14.200N 90.000W  65 420MB              3.45
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CGS-B   28 05 67 14 37 53.3 14.194N 90.872W   33 370MB       0    N 3.00
CGS-B   11 12 65 19 20 43.6 14.100N 90.900W   33 410MB       0      3.29
CGS-B   14 12 64 21 29 05.6 13.900N 90.500W   33 440MB       0      3.79
CGS-B   02 04 65 01 13 29.5 13.800N 90.800W   33 390MB       0      3.00
CGS-B   26 05 65 04 58 39.2 13.700N 90.600W   39 520MB       0      5.11
CGS-B   30 03 65 14 01 00.2 13.800N 90.800W   33 430MB       0      3.62
CGSPDE  05 09 73 06 15 36.2 13.000N 90.600W   33 420MB              3.45
CGSPDE  24 02 75 14 19 42.1 14.800N 91.900W   33 460MB              4.11
CGS-B   27 01 67 05 06 14.0 13.119N 92.939W   43 470MB       0      4.28
CGS-B   29 09 63 23 08 20.8 14.500N 92.000W   42 450MB       0      3.95
CGS-B   26 04 64 01 17 11.7 14.900N 92.500W   45 420MB       0      3.45
CGS-B   26 01 67 16 10 33.7 14.906N 92.965W   57 540MB  540BRK D 5.40
CGS 35  29 04 70 16 25 49.5 14.714N 92.493W   33 440MB       0    N*3.79

****  S5 - COASTLINE
CGS-B   20 09 66 09 51 07.7 13.800N 89.000W    8 440MB       0      3.79
CGS-B   06 02 65 08 14 08.8 13.800N 89.300W   16 430MB       0      3.62
CGS 77  16 10 68 06 08 45.5 13.893N 88.250W   16 430MB       0      3.62
CGS-B   28 09 64 05 25 12.1 13.500N 90.000W   33 430MB       0      3.62
CGS-B   30 03 67 05 30 44.3 13.873N 89.532W   33 400MB       0    N 3.12
CGS-B   03 05 65 10 01 35.2 13.500N 89.300W   23 510MB       0      4.95
CGS-B   22 07 63 00 16 33.1 13.500N 89.900W   34 400MB       0      3.12
CGS-B   25 12 65 04 13 29.7 13.900N 89.400W   33 430MB       0      3.62
CGS 16  08 02 69 04 56 59.7 13.524N 88.271W   33 430MB       0    N 3.62
CGS-B   29 10 64 12 21 52.9 13.200N 88.500W   33 400MB       0      3.12
CGS-B   24 04 66 15 41 03.2 13.700N 88.300W   33 390MB       0      3.00
CGSPDE  06 11 67 18 49 26.2 13.500N 88.000W   33 430MB       0      3.62
CGS-B   27 11 64 10 55 11.3 13.400N 88.700W   33 410MB       0      3.29
CGSPDE  15 10 75 20 55 50.9 13.453N 88.045W   33 470MB              4.28
CGS-B   03 12 64 02 00 28.6 13.500N 89.000W   41 420MB       0      3.45
CGS 55  03 08 69 21 17 16.9 13.342N 88.342W   52 430MB       0     *3.62
CGS 59  04 09 69 06 25 28.1 13.216N 88.429W   53 460MB       0      4.12
ERL 51  31 08 72 02 24 09.6 13.272N 88.513W   50 540MB       0      4.80
CGSPDE  17 12 74 15 31 16.4 13.200N 88.500W   50 500MB              4.77

****  S6 - GUATEMALA-MEXICO
ERL 77  13 10 71 01 52 51.8 13.937N 91.144W   33 450MB       0    N*3.95
ERL 80  18 10 71 16 40 50.5 13.941N 91.138W   36 470MB       0     *4.28
CGS-B   22 10 64 15 10 58.5 13.700N 91.400W   33 380MB       0      3.00
ERL 77  12 10 71 09 44 59.3 13.844N 91.172W   36 570MB  600BRK      5.70
ERL 79  22 10 71 17 49 00.1 13.780N 91.239W   20 450MB       0      3.60

****  S7 - GUATEMALA - MEXICO
ERL 21  22 03 72 07 16 52.1 13.038N 90.948W   16 430MB       0     *3.30
CGS-B   03 02 65 18 35 11.6 16.100N 90.300W   33 410MB       0      3.29
ERL 18  26 02 72 15 25 33.1 13.987N 91.022W   33 460MB       0    N*4.12
ERL 10  15 01 72 19 21 20.8 13.938N 90.988W   33 470MB       0    N 4.28
CGSPDE  26 08 74 06 27 40.7 13.000N 91.000W   33 510MB              4.94
ISS     20 02 59 18 16 20.0 13.940N 90.590W   48   0    650PAS      6.50
CGS 11  31 01 70 22 23 37.1 13.727N 88.750W   46 500MB       0      4.50

****  S8 - MIXCO
CGSPDE  04 02 76 09 03 28.3 14.700N 90.600W    5 580MB              6.11
CGSPDE  06 02 76 18 19 17.7 14.700N 90.600W    5 580MB              6.11
CGSPDE  07 03 76 03 15 40.3 14.700N 90.500W    5 490MB              4.62
CGSPDE  11 02 76 09 32 20.4 14.808N 90.510W   10                    3.10
CGSPDE  11 02 76 22 10 58.8 14.537N 90.680W    4                    3.30
CGSPDE  12 02 76 04 39 54.5 14.536N 90.668W    7                    3.00
CGSPDE  12 02 76 07 44 35.7 14.532N 90.619W   12                    3.00
CGSPDE  12 02 76 12 03 33.5 14.589N 90.625W   13                    3.20
CGSPDE  14 02 76 03 15 59.8 14.969N 90.545W   10                    3.20
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CGS-B   27 06 65 08 42 44.1 13.400N 92.800W   73 400MB       0      3.12
CGSPDE  06 12 67 03 33 46.4 13.100N 92.500W   77 440MB       0      3.79
CGS101  15 12 68 06 59 27.8 13.424N 92.977W   75 360MB       0      3.00
CGS 33  22 04 69 12 51 09.1 14.851N 91.658W   79 410MB       0      3.29
CGS-B   12 08 66 14 40 56.0 14.500N 89.900W   77 380MB       0      3.00

****  S4 - COASTLINF
CGS-B   05 02 65 08 35 24.2 13.200N 93.500W   17 410MB       0      3.29
CGSPDE  08 07 67 08 45 31.7 14.500N 91.600W   33 400MB       0      3.12
CGS-B   29 08 65 02 32 51.3 14.000N 90.900W   28 440MB       0      3.79
CGS     23 10 50 17 47 51.0 14.500N 92.000W    0   0    650PAS      6.50
CGS     24 10 50 05 50 15.0 14.500N 92.000W    0   0    600BRK      6.00
CGS     05 11 50 16 35 20.0 14.500N 92.000W    0   0    625PAS      6.25
GUTE    14 12 35 22 05 17.0 14.750N 92.500W    0   0    730PAS      7.30
CGS     11 03 59 14 31 33.0 14.500N 92.000W    0   0    500TAC      5.00
GUTE    05 12 39 08 30 07.0 14.500N 91.500W    0   0    675PAS      6.75
ISS     23 10 50 23 38 43.0 14.300N 91.700W    0   0    610PAS      6.10
GUTE    23 10 50 16 13 20.0 14.500N 91.500W    0   0    710PAS      7.10
ISS     17 02 50 03 47 16.0 13.900N 90.800W    0   0    638PAS      6.38
ISS     21 10 54 06 51 44.0 13.900N 90.600W    0   0    650PAS      6.50
CGS-B   08 02 66 02 59 26.3 14.900N 92.900W   13 420MB       0      3.45
CGS-B   30 04 67 16 28 14.6 14.138N 91.387W   15 480MB       0      4.45
CGS-B   14 06 63 07 18 50.8 13.000N 93.100W   33 370MB       0      3.00
CGS-B   28 05 64 06 27 32.8 13.500N 93.100W   33 370MB       0      3.00
CGS-B   25 01 65 08 51 42.4 13.900N 93.500W   33 390MB       0      3.00
CGS-B   04 03 65 02 44 51.4 13.900N 93.500W   33 400MB       0      3.12
CGS-B   24 06 64 19 28 02.6 13.400N 93.300W   33 390MB       0      3.00
CGS-B   29 09 64 06 30 30.6 13.800N 93.300W   33 390MB       0      3.00
CGSPDE  17 11 67 21 20 28.3 13.700N 93.500W   33 380MB       0      3.00
CGS-B   21 07 64 18 05 40.2 13.500N 93.200W   33 370MB       0      3.00
CGS-B   27 02 67 03 15 19.2 13.086N 93.388W   33 360MB       0    N*3.00
CGS-B   21 02 64 03 15 07.9 13.000N 92.800W   33 380MB       0      3.00
CGSPDE  15 06 68 10 43 22.0 13.273N 92.826W   33 400MB       0    N*3.12
CGS-B   18 03 64 11 39 26.8 14.700N 92.100W   31 400MB       0      3.12
CGS-B   10 01 65 02 48 00.8 14.500N 92.200W   33 390MB       0      3.00
CGSPDE  14 01 68 18 56 40.8 14.400N 92.200W   33 420MB       0      3.45
CGSPDE  17 08 67 17 34 33.8 14.400N 92.900W   33 410MB       0      3.29
CGS 44  03 07 69 05 38 13.8 14.765N 92.495W   34 400MB       0     *3.12
CGS-B   10 12 66 14 10 22.9 14.000N 92.300W   37 420MB       0      3.45
CGS 80  23 09 68 04 49 38.0 14.882N 92.900W   33 420MB       0    N*3.45
CGS-B   31 07 63 15 37 20.3 14.500N 92.200W   33 390MB       0      3.00
CGS-B   14 06 65 23 19 44.2 14.400N 92.100W   33 410MB       0      3.29
CGS-B   05 08 64 02 54 38.2 14.500N 92.100W   33 390MB       0      3.00
CGS-B   07 08 64 03 15 25.2 14.500N 92.000W   33 380MB       0      3.00
CGS-B   13 12 66 11 51 38.5 14.700N 92.500W   33 380MB       0      3.00
CGS-B   29 09 63 23 05 22.5 14.300N 92.000W   33 440MB       0      3.79
CGS-B   10 12 66 15 16 07.5 14.600N 92.000W   33 380MB       0      3.00
CGS-B   16 02 64 10 46 24.7 14.000N 92.400W   33 410MB       0      3.29
CGS-B   08 02 66 06 19 52.7 14.900N 92.900W   33 390MB       0      3.00
CGS-B   26 08 63 01 30 08.7 14.400N 91.300W   33 380MB       0      3.00
CGSPDE  24 11 67 09 20 03.7 14.100N 91.100W   33 420MB       0      3.45
CGS-B   30 05 64 20 02 21.7 14.000N 91.800W   23 370MB       0      3.00
CGS-B   12 08 66 08 53 36.5 14.700N 91.100W   33 380MB       0      3.00
ERL 70  12 09 71 05 32 03.4 14.112N 91.270W   33 430MB       0    N*3.62
CGS-B   08 02 64 09 59 17.4 14.400N 91.300W   33 410MB       0      3.29
CGS-B   11 03 67 16 39 57.2 14.572N 91.489W   27 370MB       0      3.00
CGS 36  09 05 69 10 09 01.3 14.647N 91.562W   33 380MB       0    N*3.00
CGS-B   17 04 65 07 02 50.1 14.100N 91.300W   33 360MB       0      3.00
CGS-B   02 02 65 03 37 13.9 14.000N 91.000W   33 490MB       0      4.62
CGS-B   23 06 66 13 33 36.8 14.600N 91.300W   33 420MB       0      3.45
CGS-B   11 12 65 15 30 09.1 14.200N 90.800W   33 420MB       0      3.45
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CGS-B   03 02 67 09 05 33.5 14.594N 93.486W   6 440MB       0      3.79
CGS-B   20 10 66 18 28 40.5 15.800N 91.800W   5 440MB       0      3.79
CGS-B   20 03 67 08 42 06.0 15.433N 90.048W   8 370MB       0     *3.00
CGS-B   03 07 64 02 33 50.0 15.000N 90.900W   8 390MB       0      3.00
CGS 32  30 04 70 21 12 06.6 14.574N 93.597W  19 470MB       0      4.28
CGSPDE  26 07 68 06 33 59.6 14.395N 93.049W  14 490MB       0      5.70
CGS 31  30 04 70 08 32 59.1 14.698N 93.192W  19 560MB  620PAS      6.40
CGS-B   07 03 66 09 10 53.9 14.000N 93.100W  17 500MB       0      4.78
CGS-B   17 02 66 01 24 13.9 14.500N 92.800W  19 370MB       0      3.00
CGS-B   16 04 65 03 57 55.0 14.000N 91.800W  17 400MB       0      3.12
CGS-B   15 06 64 11 13 47.3 12.000N 88.000W  14 410MB       0      3.29
CGSPDE  23 06 67 13 30 46.0 12.900N 87.800W  11 420MB       0      3.45
CGS 32  29 04 70 21 49 00.7 14.185N 93.380W  33 510MB       0    N*4.95
CGS 36  08 05 70 00 10 45.7 14.913N 93.158W  33 410MB       0    N*3.29
CGS-B   28 10 66 18 41 05.7 14.500N 93.200W  23 450MB       0      3.95
CGS-B   27 03 66 21 07 30.4 14.500N 93.500W  33 370MB       0      3.00
CGS 32  01 05 70 11 02 25.4 14.556N 93.381W  33 450MB       0    N 3.95
CGSPDE  21 07 68 00 23 40.4 14.563N 93.061W  37 500MB       0      4.40
CGS-B   14 04 66 05 35 10.6 14.500N 93.200W  33 390MB       0      3.00
CGS-B   14 04 66 06 54 34.6 14.400N 93.400W  33 370MB       0      3.00
CGS 32  30 04 70 08 59 07.6 14.531N 93.400W  33 520MB       0    N 5.11
CGS-B   10 04 67 20 41 49.6 14.041N 93.435W  37 420MB       0      3.45
CGS-B   12 03 67 06 16 54.6 14.148N 93.061W  35 390MB       0      3.00
CGS-B   14 06 63 08 19 16.6 14.600N 93.400W  33 400MB       0      3.12
ERL 40  30 06 72 03 56 28.6 14.048N 93.285W  33 500MB       0    N*3.70
NOS 85  15 12 70 07 54 51.6 14.590N 93.055W  33 510MB       0    N 4.90
NOS 85  15 12 70 10 53 19.5 14.456N 93.075W  33 480MB       0    N 4.45
CGS 32  03 05 70 07 39 24.5 14.568N 93.255W  33 460MB       0    N 4.12
CGS 32  30 04 70 21 56 27.5 14.710N 93.389W  33 480MB       0    N 4.45
CGS-B   09 02 66 00 55 18.5 14.500N 93.000W  28 520MB       0      5.11
CGSPDE  20 06 67 13 26 59.5 14.600N 93.500W  33 430MB       0      3.62
CGS 32  30 04 70 03 59 50.2 14.662N 93.044W  33 510MB       0    N 4.80
CGS 31  30 04 70 13 21 03.2 14.476N 93.498W  22 540MB       0      5.60
CGS 32  29 04 70 18 41 29.2 14.515N 93.031W  33 490MB       0    N 4.62
CGS-B   04 11 66 06 05 19.2 14.700N 93.300W  33 470MB       0      4.28
CGS-B   08 02 66 05 11 51.2 14.500N 93.100W  33 390MB       0      3.00
CGS 34  03 05 70 09 07 07.2 14.625N 93.539W  33 480MB       0    N*4.45
CGS 33  01 05 70 22 41 02.2 14.712N 93.400W  29 440MB       0     *3.79
CGS 35  30 04 70 23 43 43.2 14.430N 93.592W  33 440MB       0    N*3.79
CGS 32  01 05 70 04 08 07.2 14.611N 93.554W  35 510MB       0      4.95
CGS 35  30 04 70 09 13 58.1 14.327N 93.277W  33 450MB       0    N*3.95
CGS 32  29 04 70 21 20 24.1 14.556N 93.570W  35 530MB       0      5.40
ERL 35  07 06 72 23 17 30.1 14.588N 93.594W  38 410MB       0     *3.29
CGS 32  04 05 70 06 59 30.1 14.525N 93.347W  33 460MB       0    N 4.12
CGS 35  30 04 70 18 21 44.1 14.521N 93.564W  21 480MB       0      4.45
CGS-B   19 08 66 01 48 22.3 14.400N 93.000W  33 390MB       0      3.00
CGSPDE  21 06 67 03 08 43.3 14.600N 93.300W  20 410MB       0      3.29
CGS 31  30 04 70 12 51 36.3 14.447N 93.430W  24 530MB       0      5.60
CGS 34  30 04 70 03 58 24.3 14.506N 93.170W  33 450MB       0    N*3.95
CGS 32  29 04 70 19 29 52.3 14.571N 93.499W  29 520MB       0      5.11
CGS 32  29 04 70 19 38 32.3 14.561N 93.552W  33 490MB       0    N 4.62
CGS 30  17 04 70 16 20 06.3 14.533N 93.119W  33 460MB       0    N 5.10
CGS 36  17 05 70 10 29 12.3 14.078N 93.008W  23 470MB       0      4.28
CGS 46  01 07 70 19 12 32.3 14.085N 93.122W  37 460MB       0     *4.12
NOS 16  20 02 71 12 24 58.3 14.518N 93.282W  34 500MB       0      4.40
CGS-B   04 11 66 06 49 26.0 14.700N 93.300W  33 410MB       0      3.29
CGS-B   05 11 66 07 08 33.0 14.600N 93.200W  33 380MB       0      3.00
CGS-B   22 12 63 01 20 11.0 14.500N 93.000W  33 440MB       0      3.79
CGS-B   14 01 65 19 35 36.0 14.100N 93.100W  33 390MB       0      3.00
ERL 16  07 03 72 14 06 21.0 14.735N 93.558W  35 450MB       0     *3.95
NOS 85  15 12 70 10 32 59.0 14.547N 93.133W  33 520MB       0    N 5.11

CGSPDE  14 02 76 20 36 28.2 14.615N 90.583W  11                     3.50
CGSPDE  15 02 76 04 36 12.1 14.608N 90.551W   3                     3.40
CGSPDE  16 02 76 07 58 08.6 14.648N 90.678W  12                     3.00
CGS 13  08 02 70 16 19 20.7 14.570N 90.237W  33 460MB       0       4.12
CGS-B   05 12 66 16 11 27.2 14.400N 90.500W  53 420MB       0       3.45
CGSPDE  02 12 74 12 36 44.5 14.500N 91.500W  97 520MB               5.10
CGS     11 03 54 10 30 10.0 14.500N 90.500W 100   0    575PAS       5.75

****  S9 - "MEXICO"
CGS     29 07 54 22 23 54.0 17.500N 92.500W   0   0    550TAC       5.50
CGS-B   29 04 63 20 35 39.3 17.500N 92.400W   9 530MB       0       5.28
CGS-B   14 01 67 15 58 11.2 15.929N 91.190W   5 430MB       0       3.62
CGSPDE  06 08 68 03 24 04.3 17.220N 92.575W  13 440MB       0       3.79
CGS-B   26 10 66 05 55 51.4 15.800N 91.100W  18 400MB       0       3.12
CGS-B   19 05 64 04 18 05.9 16.000N 91.800W  33 410MB       0       3.29
CGSPDE  05 08 68 16 41 22.9 17.250N 92.251W  33 460MB       0       4.12
CGS-B   03 08 66 10 24 39.7 17.500N 92.400W  33 380MB       0       3.00
CGS-B   29 01 66 14 40 30.5 15.500N 91.200W  33 470MB       0       4.28
CGS-B   10 01 67 17 18 39.7 15.957N 91.094W  33 420MB       0     N 3.45
CGS 10  24 01 69 05 41 44.4 17.242N 92.319W  55 380MB       0       3.00
CGSPDE  21 01 68 23 45 17.1 15.800N 92.300W  77 540MB       0       5.45
CGS-B   03 05 63 19 18 14.5 17.600N 91.800W  90 410MB       0       3.29
CGS     05 02 54 15 17 59.0 17.500N 92.500W 100   0   F625PAS       6.25
ISS     01 04 54 23 11 27.0 17.500N 92.600W 128   0    600TAC       6.00
GUTE    30 03 14 00 41 18.0 17.000N 92.000W 150   0    750PAS       7.50
CGSPDE  30 11 67 07 00 40.1 15.800N 91.900W 150 450MB       0       3.95

****  S10 - "MEXICO"
CGSPDE  05 11 75 17 04 21.4 15.900N 92.818W  12 500MB               4.77
CGSPDE  23 10 75 01 20 03.5 17.200N 93.300W  33 510MB               4.94
CGSPDE  06 10 75 06 54 19.2 15.800N 92.900W  23 440MB               3.78
CGSPDE  06 10 75 13 42 26.0 15.500N 92.900W  21 470MB               4.28
GUTE    27 07 34 02 25 45.0 15.000N 92.500W  50   0    625PAS       6.25
ISS     25 10 51 04 06 22.0 15.500N 92.600W  96   0    575PAS       5.75
CGS-B   30 11 65 03 51 58.0 16.900N 93.200W 113 380MB       0       3.00
CGS 27  28 03 69 08 19 30.2 15.112N 92.387W 140 440MB       0     G 3.79
GUTE    28 05 37 15 35 53.0 17.000N 93.000W 150   0    650PAS       6.50
CGS     15 05 57 02 11 05.0 17.500N 93.500W 100   0    570TAC       5.70

****  S11 - JOCCTAN
GUTE    03 12 34 02 38 29.0 15.000N 88.750W   0   0    625PAS       6.25
CGSPDE  14 07 68 03 55 24.9 15.237N 88.843W  14 450MB       0       3.95
ERL 74  25 12 72 00 26 28.1 15.215N 88.943W  34 460MB       0       4.12
CGS-B   03 07 64 11 03 50.4 15.000N 88.200W  60 380MB       0       3.00
CGS-B   08 03 67 23 07 02.6 15.101N 88.782W  76 420MB       0      *3.45
CGSPDE  07 07 68 19 49 36.0 14.578N 88.939W 134 450MB       0      *3.95
GUTE    24 06 46 15 48 20.0 14.750N 89.000W 260   0    600PAS       6.00

****  S12 - B1   BENIOFF
TAC     03 09 58 01 53 24.5 14.717N 93.333W   0   0    540TAC       5.40
ISS     02 09 58 20 07 00.0 14.560N 92.990W   0   0    582STR       5.82
GUTE    19 12 32 06 28 45.0 14.000N 92.500W   0   0    560PAS       5.60
TAC     22 03 55 13 54 17.0 15.800N 91.783W   0   0    580TAC       5.80
ISS     17 11 53 13 29 52.0 15.800N 91.800W   0   0    737PAS       7.37
ISS     29 07 53 18 15 36.0 15.000N 90.000W   0   0    600PAS       6.00
GUTE    08 02 26 15 17 49.0 15.000N 89.000W   0   0    710PAS       7.10
ISS     06 05 51 23 08 01.0 15.000N 87.800W   0   0   D650TAC       6.50
GUTE    07 03 34 22 41 47.0 15.250N 87.750W   0   0    625PAS       6.25
GUTE    25 08 31 22 20 42.0 12.500N 89.500W   0   0    560PAS       5.60
CGS     19 02 54 21 34 41.0 12.500N 87.500W   0   0    663PAS       6.63
GUTE    28 03 21 07 49 22.0 12.500N 87.500W   0   0    730PAS       7.30
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CGS 29  29 04 70 12 52 52.5 14.457N 92.778W  33 450MB       0  N*3.95
ERL 26  12 04 72 16 59 12.6 14.121N 92.889W  33 450MB       0   *3.60
CGS-B   03 04 66 18 14 24.4 14.700N 92.700W  33 370MB       0    3.00
CGS 29  29 04 70 11 42 38.4 14.429N 92.635W  33 500MB       0  N 4.78
CGS 30  29 04 70 16 56 26.4 14.652N 92.697W  33 510MB       0  N 4.95
CGS 51  02 08 70 17 53 55.4 14.149N 92.739W  33 410MB       0  N*3.29
CGS 37  12 05 70 22 36 16.4 14.150N 92.770W  33 430MB       0  N*3.62
CGS-B   11 01 65 16 25 58.4 14.200N 92.000W  33 390MB       0    3.00
CGS-B   14 01 65 23 54 00.4 14.400N 92.900W  33 480MB       0    4.45
CGS 81  09 10 68 03 09 38.7 14.477N 92.887W  33 440MB       0  N 3.79
ERL 51  30 08 72 00 13 27.7 14.706N 92.822W  27 430MB       0   *3.62
CGS 34  02 05 70 05 15 43.7 14.538N 92.962W  33 510MB       0  N 5.00
CGS 32  29 04 70 12 07 30.7 14.231N 92.811W  33 510MB       0  N*4.95
CGS 34  30 04 70 11 37 18.7 14.629N 92.593W  33 470MB       0  N*4.28
CGS-B   12 11 65 13 40 34.7 14.200N 92.200W  33 370MB       0    3.00
CGS-B   10 09 66 04 13 01.7 14.500N 92.900W  33 370MB       0    3.00
CGS-B   25 06 66 21 55 57.7 14.000N 91.700W  33 380MB       0    3.00
CGS-B   02 11 66 18 51 18.0 14.100N 91.900W  33 410MB       0    3.29
CGS-B   18 04 65 21 13 37.0 14.000N 91.800W  33 420MB       0    3.45
CGS-B   28 07 65 13 55 05.0 14.000N 91.900W  33 390MB       0    3.00
CGS-B   20 05 66 03 51 18.1 14.800N 91.700W  33 400MB       0    3.12
CGS-B   19 10 66 06 13 06.8 14.000N 91.600W  35 410MB       0    3.29
ERL 77  24 09 71 08 28 43.5 13.991N 93.246W  33 440MB       0  N*3.79
CGS-B   05 02 65 08 00 22.1 13.600N 93.200W  33 370MB       0    3.00
CGS-B   16 01 65 05 54 14.1 13.900N 93.000W  33 390MB       0    3.00
CGS 36  02 05 70 05 23 49.7 13.993N 93.051W  33 460MB       0  N*4.12
CGS-B   21 08 64 03 29 18.7 13.900N 93.000W  33 440MB       0    3.79
CGS-B   20 10 64 23 48 13.9 13.600N 92.200W  33 390MB       0    3.00
CGS-B   18 04 67 16 18 28.9 13.543N 92.402W  33 440MB       0  N*3.79
CGS-B   13 04 65 01 17 30.8 13.900N 92.000W  33 410MB       0    3.29
CGS-B   01 11 64 12 07 59.0 13.900N 92.300W  33 390MB       0    3.00
CGS-B   02 10 66 12 22 24.5 13.400N 92.300W  39 420MB       0    3.45
CGS  3  10 01 70 05 37 54.5 13.551N 92.311W  33 440MB       0  N*3.79
CGS-B   26 08 64 09 00 19.5 13.900N 92.600W  33 390MB       0    3.00
CGS-B   01 01 65 11 39 30.5 13.600N 92.900W  33 450MB       0    3.95
CGS-B   01 09 61 18 50 35.4 13.600N 92.500W  37   0    650PAS    6.50
CGS 32  30 04 70 15 45 12.4 13.955N 92.873W  33 450MB       0  N*3.95
ERL 47  31 07 73 03 44 43.4 13.523N 92.295W  24 410MB       0   *3.29
ERL 66  20 08 71 21 36 09.6 13.376N 92.372W  33 580MB       0  N 5.60
CGS-B   31 08 65 23 18 05.5 13.400N 92.000W  26 470MB       0    4.28
CGS-B   14 07 66 23 28 08.6 13.400N 91.600W  36 400MB       0    3.12
CGS-B   11 06 65 22 33 06.6 13.200N 91.000W  33 390MB       0    3.00
CGS-B   17 07 66 20 44 27.0 13.400N 91.500W  33 400MB       0    3.12
CGS-B   09 05 66 03 40 57.0 13.700N 91.200W  23 440MB       0    3.79
CGS-B   12 06 65 16 35 43.5 13.700N 91.000W  33 450MB       0    3.95
CGS 25  16 03 69 06 05 50.9 13.125N 91.942W  33 390MB       0  N*3.00
CGS-B   05 10 64 22 58 04.9 13.600N 91.300W  33 440MB       0    3.79
CGS-B   19 06 65 01 39 38.7 13.100N 90.400W  32 460MB       0    4.12
ERL 37  05 06 72 06 22 36.7 13.356N 90.278W  33 470MB       0  N*4.28
CGS-B   05 02 67 05 24 21.0 13.232N 90.893W  33 430MB       0  N*3.62
ISS     02 04 51 00 13 37.0 13.000N 90.000W  33   0    638PAS    6.38
CGS-3   23 06 66 09 01 48.1 13.400N 90.300W  33 400MB       0    3.12
CGS-B   05 01 65 06 24 10.1 13.300N 90.800W  33 430MB       0    3.62
CGSPDE  02 09 68 04 53 14.1 13.108N 90.365W  33 410MB       0  N*3.29
CGS-B   22 03 66 03 41 47.4 13.100N 90.000W  20 480MB       0    4.45
CGS 54  09 08 69 01 19 04.2 13.202N 90.892W  33 400MB       0  N*3.12
CGS-B   06 07 64 09 31 56.2 13.500N 90.400W  33 400MB       0    3.12
ERL 18  09 03 73 18 19 29.5 13.611N 90.687W  33 440MB       0  N*3.79
CGS-B   29 08 66 17 35 22.3 13.500N 90.900W  33 380MB       0    3.00
ISS     03 08 51 00 23 58.0 13.000N 87.800W  33   0   F600PAS    6.00
ISS     03 08 51 05 25 44.0 13.000N 87.800W  33   0    550PAS    5.50
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CGS 31  30 04 70 05 46 22.0 14.451N 93.330W  33 490MB       0  N*4.62
CGS 31  30 04 70 09 06 57.0 14.359N 93.120W  20 460MB       0  G 4.12
CGS 39  01 06 70 18 18 35.0 14.572N 93.521W  33 460MB       0  N*4.12
CGS-B   07 03 66 11 15 27.9 14.000N 93.200W  33 400MB       0    3.12
CGS-B   16 08 66 15 00 44.9 14.500N 93.000W  33 430MB       0    3.62
CGS-B   04 11 66 06 36 38.9 14.700N 93.300W  33 480MB       0    4.45
CGS 34  29 04 70 14 51 54.9 14.583N 93.094W  33 510MB       0  N 4.95
CGS-B   25 02 67 21 53 16.1 14.200N 93.234W  33 410MB       0  N 3.29
CGS-B   01 02 66 11 41 29.1 14.900N 93.500W  33 430MB       0    3.62
ERL 26  17 04 73 07 50 10.1 14.724N 93.568W  33 400MB       0  N*3.12
CGS 36  02 05 70 09 02 30.8 14.124N 93.398W  33 440MB       0  N*3.79
CGS 33  19 05 70 00 57 11.6 14.514N 93.242W  33 460MB       0  N 4.12
CGS-B   09 08 63 01 17 37.8 14.200N 92.300W  33 410MB       0    3.29
CGS-B   30 09 63 02 33 14.6 14.500N 92.100W  33 410MB       0    3.29
ERL 21  05 04 73 07 15 07.6 14.081N 92.197W  33 440MB       0  N*3.79
CGSPDE  13 09 67 08 33 25.8 14.100N 92.300W  39 390MB       0    3.00
CGS 32  29 04 70 16 54 31.6 14.546N 92.743W  33 450MB       0  N*3.95
CGS 30  29 04 70 14 01 32.8 14.518N 92.603W  33 580MB D700PAS  N 7.30
CGS 32  30 04 70 13 10 23.6 14.407N 92.983W  33 450MB       0  N*3.95
CGS-B   28 12 63 06 57 09.9 14.400N 92.300W  33 450MB       0    3.95
CGS-B   19 01 66 04 24 58.1 14.100N 92.400W  33 410MB       0    3.29
CGS-B   12 12 66 13 52 38.1 14.500N 92.900W  33 390MB       0    3.00
CGSPDE  04 10 67 22 27 29.1 14.700N 92.300W  33 420MB       0    3.45
CGS-B   25 07 63 12 57 49.1 14.200N 92.100W  33 420MB       0    3.45
CGS 30  29 04 70 14 01 19.1 14.577N 92.751W  33 560MB       0  N 5.78
CGS 33  29 04 70 11 46 34.1 14.741N 92.594W  33 460MB       0    4.12
CGS 30  29 04 70 20 33 39.9 14.517N 92.686W  33 490MB       0  N 4.62
CGS-B   27 02 66 11 49 10.9 14.300N 92.000W  33 430MB       0    3.62
CGS-B   10 12 66 14 56 27.9 14.100N 92.000W  33 390MB       0    3.00
ERL 10  30 01 72 14 59 40.9 14.497N 92.816W  33 450MB       0  N*3.95
ERL 80  30 09 71 13 33 34.9 14.718N 92.820W  33 480MB       0  N*4.45
ISS     15 07 52 06 06 24.0 14.500N 92.300W  33   0    600PAS    6.00
ISS     21 07 57 06 04 08.5 14.550N 92.110W  38   0    588BRK    5.88
CGS-B   02 02 65 01 14 34.0 14.100N 92.400W  33 390MB       0    3.00
CGS-B   15 01 65 06 57 40.0 14.600N 92.800W  33 390MB       0    3.00
CGS-B   13 01 65 06 42 33.0 14.500N 92.100W  33 390MB       0    3.00
CGS-B   03 03 67 01 00 19.0 14.467N 92.164W  27 420MB       0    3.45
CGS-B   07 02 67 09 02 35.0 14.292N 92.240W  33 420MB       0  N*3.45
CGS-B   04 11 66 08 21 15.0 14.700N 92.700W  33 430MB       0    3.62
CGS 55  09 08 70 22 29 50.0 14.719N 92.879W  33 430MB       0  N*3.62
CGS 33  17 05 70 19 09 32.0 14.357N 92.815W  33 480MB       0  N 4.45
CGS 34  29 04 70 20 47 47.3 14.446N 92.866W  33 460MB       0  N*4.12
CGS 29  29 04 70 12 29 19.3 14.527N 92.645W  33 450MB       0  N 3.95
CGS-B   03 02 64 02 00 47.3 14.400N 92.600W  34 430MB       0    3.62
CGS-B   01 08 63 04 05 04.3 14.100N 92.300W  33 400MB       0    3.12
CGS-B   28 01 67 13 43 01.3 14.603N 92.838W  34 450MB       0    3.95
CGS-B   13 12 66 09 53 30.2 14.100N 92.300W  34 460MB       0    4.12
CGS-B   14 12 66 06 52 34.2 14.400N 92.300W  23 440MB       0    3.79
CGSPDE  17 06 68 07 56 56.2 14.591N 92.894W  33 490MB       0  N 4.62
CGSPDE  24 12 67 15 44 42.2 14.200N 92.200W  33 430MB       0    3.62
CGSPDE  17 03 68 12 35 48.2 14.400N 92.600W  25 460MB       0    4.12
ERL 41  30 06 72 12 45 20.2 14.542N 92.903W  33 490MB       0  N 4.10
CGS 30  20 03 70 13 36 03.2 14.418N 92.900W  33 420MB       0  N*3.45
CGS 33  15 05 70 09 44 45.2 14.512N 92.811W  33 540MB       0  N 5.50
CGSPDE  15 06 68 05 11 17.2 14.446N 92.871W  25 540MB       0  D 5.20
CGS-B   10 02 66 23 31 26.5 14.500N 92.800W  33 440MB       0    3.79
CGSPDE  25 03 58 13 48 22.5 14.100N 92.200W  38 410MB       0    3.29
CGS 31  29 04 70 17 03 48.5 14.559N 92.872W  33 480MB       0  N*4.45
CGS-B   24 02 65 09 37 17.6 14.200N 92.100W  33 510MB       0    4.95
CGS-B   11 12 66 06 59 32.6 14.100N 92.400W  31 450MB       0    3.95
CGS-B   03 07 66 05 22 12.6 14.800N 92.700W  33 380MB       0    3.00
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ERL 10  30 01 72 14 59 42.1 14.541N 92.750W   43 450MB      0       *3.95
NOS 37  25 05 71 22 11 12.9 14.053N 92.127W   45 490MB      0        4.62
CGS 44  27 06 70 22 53 27.0 14.695N 92.837W   41 530MB      0        5.10
CGS-B   15 02 65 15 03 14.2 14.200N 92.400W   41 390MB      0        3.00
CGSPDE  19 03 68 20 15 33.2 14.700N 92.900W   43 470MB      0        4.28
CGS 33  01 05 70 17 24 18.2 14.140N 92.914W   45 460MB      0        4.12
CGSPDE  04 10 67 09 00 06.5 14.100N 92.500W   41 450MB      0        3.95
CGS 29  29 04 70 11 22 36.4 14.518N 92.690W   41 560MB   600PAS      6.30
CGS-B   29 12 61 14 53 19.4 14.500N 92.800W   45   0     500TAC      5.00
CGS 35  04 05 70 11 24 14.0 13.995N 93.463W   40 380MB      0       *3.00
CGS 29  20 03 70 10 44 49.9 13.528N 93.026W   41 430MB      0       *3.62
CGS 16  21 02 70 10 14 16.8 13.806N 92.660W   45 460MB      0        4.12
CGS 25  09 04 70 16 24 31.0 13.212N 92.259W   41 530MB   575PAL      5.00
CGSPDE  15 09 67 23 26 32.5 13.900N 92.400W   44 430MB      0        3.62
CGSPDE  10 09 67 00 41 05.2 13.800N 92.300W   47 390MB      0        3.00
CGS-B   26 10 66 21 07 42.5 13.800N 91.300W   40 430MB      0        3.62
CGS-B   05 12 66 13 00 31.0 13.900N 91.400W   42 410MB      0        3.29
CGS-B   23 10 64 15 21 56.8 13.200N 91.600W   45 400MB      0        3.12
CGS-B   08 06 65 09 15 14.8 13.400N 91.800W   42 370MB      0        3.00
ERL 43  05 07 73 19 15 18.8 13.563N 91.202W   48 430MB      0       *3.62
CGS-B   18 03 66 21 55 56.4 13.300N 90.900W   40 430MB      0        3.62
CGS-B   24 04 66 06 03 50.8 12.900N 89.200W   47 430MB      0        3.62
ERL 73  12 12 72 00 32 24.5 12.552N 89.048W   45 450MB      0       *3.95
CGS-B   10 11 63 07 18 07.5 12.900N 88.500W   45 420MB      0        3.45
CGS-B   30 01 62 08 34 23.9 12.700N 87.500W   49   0     488PAL      4.88
CGS-B   04 04 64 06 43 20.2 12.500N 87.700W   41 430MB      0        3.62
CGSPDE  02 03 74 16 54 26.2 13.700N 91.700W   43 460MB               4.11
CGSPDE  02 09 74 22 04 31.5 13.200N 90.800W   41 450MB               3.95
CGSPDE  12 09 75 08 56 58.8 13.600N 90.900W   43 430MB               3.62
ERL 35  07 06 72 23 09 04.4 14.490N 93.078W   54 460MB      0        4.12
CGS 32  30 04 70 00 54 13.6 14.457N 93.050W   57 490MB      0        4.62
CGS 34  07 05 70 18 44 18.5 14.979N 93.536W   50 470MB      0        4.28
CGS-B   29 07 64 09 46 42.2 14.900N 93.400W   56 410MB      0        3.29
CGS-B   05 01 65 14 18 36.2 14.500N 93.300W   53 470MB      0        4.28
CGSPDE  24 06 67 15 55 02.9 14.400N 93.400W   55 380MB      0        3.00
CGS 71  24 10 70 11 45 58.9 14.584N 93.470W   54 440MB      0        3.79
CGS 39  01 06 70 06 04 49.5 14.561N 93.328W   55 470MB      0        4.28
CGS-B   11 07 64 11 16 32.8 14.100N 93.000W   51 370MB      0        3.00
CGS  7  22 01 70 15 14 28.8 14.341N 92.406W   58 550MB   513GOL      5.13
CGS-B   06 04 65 16 53 57.8 14.200N 92.600W   57 500MB      0        4.78
CGS 32  29 04 70 17 17 15.1 14.509N 92.868W   57 510MB      0        4.95
CGS 39  23 05 70 23 10 57.0 14.165N 92.957W   54 460MB      0       *4.12
CGS-B   24 02 65 08 09 17.2 14.000N 92.200W   56 500MB      0        4.78
CGS 68  10 10 70 06 44 02.4 14.546N 92.719W   51 450MB      0       *3.95
CGS-B   01 08 65 07 42 00.4 14.300N 92.800W   55 410MB      0        3.29
CGS-B   14 04 67 09 52 32.9 13.601N 93.092W   57 440MB      0        3.79
CGS-B   03 02 65 18 28 51.7 13.900N 92.000W   56 470MB      0        4.28
CGSPDF  18 07 67 04 37 10.2 13.700N 91.400W   59 400MB      0        3.12
ERL 34  11 06 72 18 21 16.7 13.453N 90.584W   52 510MB      0        4.95
CGS-B   05 07 66 04 05 02.9 13.700N 90.800W   53 400MB      0        3.12
CGS-B   09 07 64 10 48 21.5 13.000N 90.200W   56 360MB      0        3.00
CGS-B   09 04 64 04 07 58.6 13.500N 90.200W   53 370MB      0        3.00
CGSPDE  08 10 67 21 29 02.6 13.500N 90.800W   53 420MB      0        3.45
CGSPDE  26 11 67 15 14 54.5 13.100N 90.100W   58 440MB      0        3.79
CGS-B   03 01 67 17 11 20.3 13.546N 90.264W   51 430MB      0        3.62
CGS-B   04 06 66 14 12 53.3 13.200N 90.100W   55 440MB      0        3.79
CGS-B   11 12 65 23 52 59.3 13.400N 89.300W   57 410MB      0        3.29
CGS-B   10 02 65 19 30 43.2 13.000N 89.500W   55 400MB      0        3.12
CGS-B   17 11 64 16 17 03.0 13.200N 89.600W   54 450MB      0        3.95
CGSPDE  06 05 68 21 23 11.0 13.021N 87.734W   56 460MB      0      D*4.12
CGS-B   12 09 64 21 19 38.7 12.300N 89.100W   55 420MB      0        3.45
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ISS     02 08 51 20 30 17.0 13.000N 87.800W   33   0     575PAS      5.75
CGS-B   23 10 66 22 32 40.6 12.500N 91.400W   33 390MB      0        3.00
NOS-B   20 05 67 21 38 12.1 12.[illegible] 91.322W   33 400MB      0      N*3.12
CGS-B   10 11 64 19 13 25.1 12.500N 90.300W   33 420MB      0        3.45
CGS-B   06 06 65 03 37 37.0 12.700N 90.100W   30 400MB      0        3.12
CGS 68  04 10 70 13 28 39.8 12.687N 90.318W   33 420MB      0      N*3.45
CGSPDE  07 08 68 05 17 08.3 12.605N 89.720W   37 420MB      0        3.45
CGS-B   08 05 67 14 40 08.3 12.974N 88.073W   33 460MB      0      N 4.12
CGS-B   12 04 66 17 30 49.2 12.600N 88.000W   33 440MB      0        3.79
CGS-B   15 04 67 22 10 08.8 12.743N 88.163W   33 430MB      0      N*3.62
CGS-B   27 09 65 17 37 53.8 12.900N 88.400W   33 420MB      0        3.45
CGS-B   27 06 65 13 08 28.6 12.600N 87.900W   33 410MB      0        3.29
CGS-B   02 04 64 03 48 59.6 12.500N 87.800W   32 420MB      0        3.45
CGS-B   23 12 66 22 10 25.0 12.600N 87.700W   32 450MB      0        3.95
CGS 48  05 07 70 05 42 05.0 12.561N 87.446W   33 450MB      0      N 3.95
CGS-B   09 05 63 15 06 24.4 12.700N 86.600W   33 410MB      0        3.29
CGSPDE  21 11 73 16 13 40.1 14.200N 92.600W   33 450MB               3.95
CGSPDE  03 12 73 12 05 30.7 14.100N 92.000W   33 450MB               3.95
CGSPDE  05 01 74 12 38 25.7 14.000N 92.500W   33 430MB               3.62
CGSPDE  20 04 74 07 41 20.7 13.000N 90.000W   23 470MB               4.28
CGSPDE  21 07 74 11 43 52.5 14.500N 92.300W   33 480MB               4.44
CGSPDE  03 09 74 12 46 54.1 14.200N 93.300W   33 430MB               3.62
CGSPDE  05 09 74 09 55 32.9 13.700N 91.700W   33 460MB               4.11
CGSPDE  20 09 74 11 59 43.2 13.800N 91.100W   33 500MB               4.77
CGSPDE  17 10 74 23 09 19.9 13.500N 93.100W   20 460MB               4.11
CGSPDE  04 11 74 12 34 51.4 13.000N 90.100W   33 430MB               3.62
CGSPDE  04 11 74 21 23 24.0 12.700N 90.100W   33 470MB               4.28
CGSPDE  12 11 74 05 03 49.1 13.100N 91.300W   33 430MB               3.62
CGSPDE  31 12 74 20 21 09.0 14.130N 91.820W   39 570MB               5.93
CGSPDE  01 01 75 02 12 44.7 13.400N 91.700W   33 430MB               3.62
CGSPDE  01 01 75 11 54 29.2 13.200N 91.900W   33 400MB               3.12
CGSPDE  09 01 75 15 20 26.1 13.200N 91.900W   33 440MB               3.78
CGSPDE  01 03 75 12 37 32.6 12.500N 89.600W   33 440MB               3.78
CGSPDE  25 03 75 02 31 22.2 13.600N 90.700W   33 520MB               5.10
CGSPDE  29 03 75 09 30 19.8 12.900N 88.400W   33 450MB               3.95
CGSPDE  23 04 75 15 03 51.9 13.730N 92.200W   33 460MB               4.11
CGSPDE  01 05 75 11 50 03.0 13.200N 91.600W   33 440MB               3.78
CGSPDE  22 05 75 12 51 11.9 12.700N 87.900W   33 500MB               4.77
CGSPDE  21 05 75 16 41 57.8 13.500N 89.800W   33 460MB               4.11
CGSPDE  04 06 75 19 36 21.5 12.700N 88.500W   33 460MB               4.11
CGSPDE  07 06 75 16 07 01.1 14.400N 92.500W   33 450MB               3.95
CGSPDE  12 07 75 16 20 35.0 14.400N 93.200W   33 440MB               3.78
CGSPDE  22 08 75 23 08 16.9 14.600N 93.500W   38 520MB               5.10
CGSPDE  04 09 75 19 14 06.4 12.900N 90.700W   33 470MB               4.28
CGSPDE  26 01 76 07 28 43.5 13.692N 90.848W   33 480MB               4.44
CGSPDE  10 01 76 10 54 55.7 14.205N 93.001W   38 440MB               3.78
ISS     16 02 59 17 54 15.0 13.110N 87.340W    0   0     540TAC      5.40
ISS     07 05 51 20 22 21.0 13.000N 87.800W    0   0     600TAC      6.00
CGS     04 04 55 19 24 04.0 13.000N 87.000W    0   0     625PAS      6.25

****   S13 - B2   BENIOFF
CGS-B   20 02 64 12 03 18.7 14.500N 93.000W   49 440MB      0        3.79
CGS 32  01 05 70 08 23 03.4 14.514N 93.586W   49 500MB      0        4.78
CGS 31  30 04 70 21 53 10.5 14.535N 93.561W   42 470MB      0        4.28
CGS 75  23 09 68 05 11 23.2 14.597N 93.129W   43 430MB      0        3.62
CGS 34  01 05 70 08 35 24.2 14.635N 93.158W   44 540MB   600PAS      6.00
CGS M6  27 11 69 01 39 13.2 14.252N 93.169W   46 470MB      0        4.28
CGSPDE  16 08 67 15 22 04.1 14.400N 93.200W   45 380MB      0        3.00
CGS-B   30 07 62 10 19 38.5 14.600N 93.100W   46   0     475PAL      4.75
CGS-B   05 01 65 19 29 38.0 14.700N 93.100W   47 440MB      0        3.79
CGS-B   17 02 67 13 09 41.1 14.507N 93.258W   41 370MB      0       *3.00
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CGS 63  23 08 69 16 41 29.8 13.930N 92.820W  65 400MB    0      G*3.12
CGS-B   21 11 65 03 30 58.0 13.500N 92.200W  68 440MB    0        3.79
ERL 68  06 09 71 09 58 48.2 13.921N 92.540W  60 510MB    0        4.95
CGS-B   03 09 63 06 38 07.2 13.600N 91.200W  62 440MB    0        3.79
CGS 44  02 07 69 05 18 20.8 13.972N 91.178W  61 420MB    0        3.45
CGS 44  07 06 70 04 53 39.6 13.682N 91.176W  62 420MB    0       *3.45
ERL 54  22 08 71 11 01 59.0 13.739N 91.404W  69 480MB    0        4.45
CGS-B   21 10 66 10 36 16.0 13.700N 91.200W  69 480MB    0        4.45
ISS     11 09 56 09 54 37.0 13.540N 91.190W  64   0    613PAS     6.13
CGS-B   06 05 64 01 26 32.1 13.400N 91.400W  69 400MB    0        3.12
CGS 82  30 10 68 10 51 50.8 13.418N 91.069W  64 410MB    0        3.29
CGS-B   25 12 66 02 20 05.7 13.500N 90.800W  63 370MB    0        3.00
CGS-B   01 10 64 18 19 43.8 13.600N 90.100W  62 440MB    0        3.79
ISS     03 09 55 12 36 21.0 13.800N 90.800W  64   0    663PAS     6.63
CGS-B   13 03 64 18 51 15.0 13.700N 90.700W  64 440MB    0        3.79
CGS-B   02 10 65 23 03 06.1 13.700N 90.700W  69 390MB    0        3.00
CGS-B   22 03 65 07 53 07.4 13.900N 90.900W  60 450MB    0        3.95
CGS-B   07 08 63 18 36 46.6 13.500N 90.900W  67 470MB    0        4.28
CGS 66  12 10 69 22 48 15.2 13.211N 90.587W  68 400MB    0        3.12
CGS 64  24 09 69 11 40 53.3 13.154N 90.934W  63 430MB    0        3.62
CGS-B   03 03 67 19 39 46.3 13.078N 90.392W  65 400MB    0       *3.12
CGS-B   23 05 67 19 12 20.3 13.340N 90.721W  68 450MB    0        3.95
CGSPDE  10 09 67 15 51 42.3 13.200N 89.500W  69 380MB    0        3.00
CGS-B   20 10 66 03 40 07.2 13.100N 89.700W  67 410MB    0        3.29
CGS 43  07 07 69 04 20 29.6 13.082N 89.014W  64 440MB    0        3.79
CGS 68  10 10 69 02 32 56.6 13.467N 89.751W  65 410MB    0        3.29
CGS 43  27 06 69 13 20 09.5 13.321N 89.529W  63 430MB    0        3.62
CGS-B   09 04 67 05 28 16.1 13.059N 89.243W  69 410MB    0       *3.29
CGS     26 04 55 03 03 34.0 13.500N 89.500W  60   0    650PAS     6.50
CGS-B   13 11 66 06 04 09.0 13.500N 89.600W  69 460MB    0        4.12
CGS-B   01 02 65 15 43 52.8 13.100N 89.600W  62 420MB    0        3.45
CGS-B   18 09 66 10 51 08.9 13.200N 89.600W  66 410MB    0        3.29
CGS 95  10 12 68 18 07 33.7 13.214N 89.597W  69 430MB    0        3.62
CGS 68  09 10 69 09 06 02.7 13.501N 89.778W  67 430MB    0        3.62
CGS-B   03 02 64 01 46 27.9 13.000N 88.000W  61 410MB    0        3.29
CGS     27 06 58 05 44 28.0 13.000N 88.500W  60   0   F600PAS     6.00
CGS 80  22 10 68 06 42 01.5 13.208N 88.247W  64 470MB    0        4.28
CGS-B   20 12 63 22 28 31.2 13.200N 88.000W  64 430MB    0        3.62
CGS-B   21 07 64 07 01 59.3 13.100N 88.400W  68 470MB    0        4.28
CGS-B   16 08 64 07 30 12.4 13.300N 87.600W  60 390MB    0        3.00
CGS-B   29 10 66 14 21 50.7 12.900N 89.300W  68 410MB    0        3.29
CGS 37  09 05 69 10 47 56.8 12.889N 89.190W  68 410MB    0       *3.29
ERL 38  25 06 72 01 52 25.9 12.608N 89.062W  65 440MB    0        3.79
CGS-B   30 09 63 14 01 20.9 12.900N 89.000W  65 370MB    0        3.00
CGS-B   23 09 66 19 01 54.5 12.900N 89.500W  65 440MB    0        3.79
CGS-B   26 07 64 03 58 29.6 12.700N 89.600W  65 480MB    0        4.45
CGS 45  28 06 69 04 34 42.6 12.618N 89.217W  69 520MB  513BRK     5.13
CGS-B   02 03 64 16 09 46.1 12.500N 88.000W  63 440MB    0        3.79
CGS-B   19 05 61 09 25 41.3 12.800N 88.200W  68   0    463PAL     4.63
ERL 49  19 08 73 22 17 49.4 12.651N 88.507W  68 510MB    0      D 4.95
ERL 14  04 03 72 22 04 23.4 12.933N 88.743W  64 470MB    0        4.28
ERL 15  07 03 73 13 00 45.2 12.705N 88.027W  64 460MB    0       *4.12
CGSPDE  26 01 68 10 37 56.8 12.700N 88.600W  60 390MB    0        3.00
CGS-B   04 05 66 18 13 55.7 12.500N 87.700W  68 510MB    0        4.95
CGS-B   08 08 64 15 45 10.9 12.500N 87.800W  63 580MB    0        6.11
CGS-B   21 02 64 07 24 08.0 12.600N 87.900W  62 390MB    0        3.00
ERL 85  25 11 71 22 06 26.1 12.739N 87.458W  62 490MB    0        4.62
CGSPDE  19 08 73 22 17 49.4 12.700N 88.500W  68 510MB             4.94
CGSPDE  08 09 73 15 59 59.6 12.800N 89.800W  63 410MB             3.29
CGSPDE  01 10 73 08 40 06.5 13.300N 89.800W  68 450MB             3.95
CGSPDE  04 12 73 08 45 00.5 14.200N 91.900W  61 430MB             3.62

CGSPDE  18 11 67 12 53 00.8 12.900N 89.700W  50 450MB    0        3.95
CGS-B   15 06 64 09 41 24.2 12.600N 88.300W  55 410MB    0        3.29
CGSPDE  18 04 68 04 40 38.7 12.500N 88.600W  54 490MB    0        4.62
CGS-B   30 08 64 15 20 50.7 12.600N 88.500W  54 460MB    0        4.12
CGS-B   04 07 63 01 43 20.8 12.500N 88.700W  55 410MB    0        3.29
CGS-B   13 07 66 08 20 58.8 12.600N 87.800W  56 530MB    0        5.28
CGS-B   06 12 65 04 39 10.4 12.500N 87.300W  50 450MB    0        3.95
CGS-B   15 05 64 02 13 56.6 12.600N 87.500W  51 370MB    0        3.00
CGSPDE  19 09 73 23 42 48.6 12.700N 88.000W  55 500MB             4.77
CGSPDE  21 11 73 13 31 32.1 14.500N 92.700W  59 530MB             5.27
CGSPDE  25 11 73 15 11 00.3 13.900N 92.700W  51 440MB             3.78
CGSPDE  03 05 74 07 56 37.0 14.000N 92.100W  53 470MB             4.28
CGSPDE  19 07 74 20 40 29.6 14.500N 92.300W  59 450MB             3.95
CGSPDE  09 01 75 06 12 47.4 14.000N 92.000W  59 460MB             4.11
CGSPDE  24 03 75 06 59 56.5 13.500N 90.800W  59 490MB             4.61
CGS-B   12 08 66 08 53 36.5 14.700N 91.100W  33 380MB    0        3.00

****  S14 - 83  BENIOFF
CGS-B   14 09 64 13 33 33.7 13.000N 93.200W  64 490MB    0        4.62
CGS 89  21 11 68 01 15 17.5 13.521N 93.391W  61 390MB    0       *3.00
CGSPDE  25 10 67 15 36 20.7 14.500N 93.100W  61 450MB    0        3.95
CGS J1  20 05 70 04 13 04.6 14.418N 93.217W  60 480MB    0      G*4.45
CGSPDE  04 05 68 10 28 58.2 14.956N 93.509W  61 460MB    0        4.12
CGS-B   28 07 62 13 58 39.3 14.500N 93.000W  63   0    450PAL     4.50
CGS-B   27 05 64 04 22 38.6 14.500N 93.500W  63 440MB    0        3.79
ISS     16 06 59 08 02 08.6 14.650N 93.520W  64   0    530TAC     5.30
CGS-B   25 06 64 05 58 47.1 14.500N 93.400W  69 480MB    0        4.45
CGS-B   23 12 65 02 44 54.8 14.700N 92.600W  65 420MB    0        3.45
CGSPDE  25 10 67 16 11 14.8 14.500N 92.900W  60 420MB    0        3.45
ERL 84  23 11 71 05 08 19.1 14.092N 92.542W  63 410MB    0       *3.29
CGS 82  28 10 68 21 51 10.1 14.473N 92.665W  67 460MB    0        4.12
CGS101  29 12 68 17 36 29.9 14.488N 92.404W  60 540MB  525BRK     5.25
NCS 23  25 03 71 05 14 52.9 14.133N 92.188W  63 420MB    0       *3.45
CGS-B   30 10 65 12 47 10.0 14.700N 92.500W  65 410MB    0        3.29
CGS-B   10 12 66 13 06 32.0 14.300N 92.000W  60 560MB    0        5.78
CGSPDE  04 07 68 00 55 41.0 14.603N 92.432W  66 420MB    0       *3.45
CGS 33  01 05 70 11 31 34.3 14.694N 92.908W  68 400MB    0       *3.12
CGSPDE  03 08 68 23 12 38.2 14.197N 92.188W  67 380MB    0       *3.00
CGS 40  21 05 70 15 46 28.2 14.355N 92.789W  62 460MB    0        4.12
CGS 35  15 05 70 07 44 18.5 14.387N 92.961W  64 470MB    0        4.28
NCS 23  24 03 71 16 18 29.6 14.125N 92.279W  64 500MB    0        4.78
CGS-B   13 05 63 12 44 01.4 14.600N 92.900W  61 560MB    0        5.78
CGS-B   07 01 65 11 05 01.4 14.400N 92.700W  69 410MB    0        3.29
CGS-B   09 11 64 09 56 10.5 14.000N 92.200W  61 380MB    0        3.00
NOS 26  14 03 71 03 59 49.7 14.142N 92.619W  68 400MB    0       *3.12
CGS-B   13 04 66 00 54 42.7 14.100N 92.500W  60 460MB    0        4.12
CGS-B   12 03 66 00 53 22.7 14.900N 92.700W  60 430MB    0        3.62
CGSPDE  26 09 67 11 32 11.5 14.300N 91.700W  68 440MB    0        3.79
CGS-B   16 04 65 11 01 52.4 14.000N 91.500W  65 450MB    0        3.95
NOS 16  19 02 71 06 27 58.2 14.151N 91.672W  68 500MB    0        4.78
CGS-B   16 09 66 14 52 50.3 14.100N 91.400W  61 440MB    0        3.79
CGS-B   24 07 64 01 39 39.0 14.200N 91.600W  65 490MB    0        4.62
CGS     28 08 55 20 13 30.0 14.000N 91.000W  60   0    675PAS     6.75
ISS     28 10 50 22 15 47.0 14.500N 91.700W  64   0    625TAC     6.25
CGSPDE  09 06 68 10 21 35.9 14.623N 91.980W  60 500MB    0      G 4.78
CGS-B   29 09 63 22 44 02.9 14.400N 91.900W  61 510MB    0        4.95
CGS-B   21 04 66 06 09 39.8 14.000N 90.800W  66 400MB    0        3.12
ISS     25 07 51 18 42 19.0 14.500N 90.500W  64   0    625PAS     6.25
CGSPDE  27 08 67 06 32 13.2 14.200N 89.600W  65 430MB    0        3.62
CGS-B   31 07 64 12 44 52.0 14.400N 88.900W  68 380MB    0        3.00
CGS-B   15 02 67 09 18 06.5 13.975N 93.307W  64 410MB    0       *3.29
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NOS 23  26 02 71 02 00 10.0 12.555N 89.925W   71 400MB      0      *3.12
ERL 66  19 11 72 04 35 24.1 12.973N 88.524W   73 560MB      0       5.78
CGS 33  03 05 69 03 19 06.3 12.987N 88.449W   77 450MB      0       3.95
CGS 25  01 04 69 21 19 53.6 12.877N 88.233W   71 490MB      0       4.62
CGS 26  08 04 69 19 41 58.5 12.070N 88.340W   76 480MB      0       4.45
ERL 32  30 04 72 10 55 19.5 12.596N 88.668W   77 440MB      0       3.79
CGS 62  06 09 70 20 44 49.7 12.783N 88.595W   75 450MB      0       3.95
CGS 34  21 04 70 05 37 08.8 12.947N 87.880W   79 520MB      0       5.11
CGS-B   22 03 67 09 15 29.2 12.033N 87.823W   70 440MB      0       3.79
CGS-B   20 10 65 23 54 30.4 12.000N 87.300W   72 540MB      0       5.45
CGSPDE  28 01 68 08 47 20.5 12.000N 87.900W   75 440MB      0       3.79
CGSPDE  24 03 68 17 13 20.0 12.500N 86.500W   79 510MB      0       4.95
CGSPDE  21 08 73 12 42 32.5 13.500N 90.600W   70 390MB              3.00
CGSPDE  02 02 74 07 07 40.6 14.100N 92.000W   75 510MB              4.94
CGSPDE  04 03 74 14 56 52.1 13.500N 90.600W   79 460MB              4.11
CGSPDE  02 05 74 03 12 54.0 13.900N 90.700W   76 470MB              4.28
CGSPDE  21 07 74 08 28 35.3 14.500N 92.100W   70 530MB              5.27
CGSPDE  31 12 74 20 15 32.7 14.100N 91.900W   75 540MB              5.43
CGSPDE  31 12 74 21 56 10.0 14.200N 91.900W   75 490MB              4.61
CGSPDE  26 06 75 06 45 17.5 14.000N 90.800W   76 480MB              4.44
CGSPDE  15 12 75 14 27 57.6 14.370N 92.588W   77 500MB              4.77
CGS     28 04 59 11 09 30.0 15.000N 93.000W    0   0     663PAS    6.63
CGS-B   04 11 66 07 13 05.0 15.000N 93.200W   49 390MB      0       3.00
CGS-B   14 04 66 12 43 20.0 15.000N 93.300W   46 390MB      0       3.00
ERL 38  01 07 72 00 32 48.5 14.011N 91.423W   47 440MB      0      *3.79
CGS-B   21 10 66 10 33 25.2 14.100N 91.100W   56 470MB      0       4.28
CGS-B   16 12 63 10 49 52.5 13.900N 90.900W   59 430MB      0       3.62

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CGS-B   03 12 66 04 33 41.7 15.900N 93.300W   89 380MB      0       3.00
ERL 12  23 01 72 11 11 43.1 15.813N 93.381W   87 460MB      0     D*4.12
CGS 76  30 09 68 03 50 51.9 15.327N 93.046W   80 450MB      0     G 3.95
CGS 52  24 07 70 21 02 32.6 15.329N 92.684W   85 420MB      0     G 3.45
CGS 85  11 11 68 03 11 06.8 15.035N 92.790W   80 510MB      0       4.95
ERL 39  08 06 73 10 32 04.3 14.472N 92.052W   89 460MB      0       4.12
CGS-B   20 04 65 13 12 46.4 14.300N 92.200W   84 440MB      0       3.79
CGS-B   02 04 67 11 58 32.4 14.735N 92.951W   89 450MB      0       3.95
CGS-B   17 06 61 15 07 33.7 14.200N 92.000W   85   0     600PAS    6.00
CGS-B   18 08 66 10 33 17.7 14.000N 91.700W   85 560MB      0       5.78
CGS  1  03 01 69 11 19 13.6 14.476N 91.653W   89 500MB      0       4.78
CGS-B   15 04 63 22 35 58.6 14.300N 91.900W   88 460MB      0       4.12
CGS-B   19 06 64 13 45 13.2 14.100N 91.400W   85 390MB      0       3.00
CGS-B   07 08 64 15 31 18.0 14.000N 91.900W   89 500MB      0       4.78
GUTE    31 08 43 16 10 40.0 14.250N 91.500W   80   0     675PAS    6.75
GUTE    05 12 37 05 42 09.0 14.000N 91.000W   80   0     550PAS    5.50
CGS-B   30 09 63 03 05 38.1 14.100N 91.900W   86 450MB      0       3.95
CGS 29  21 04 69 02 19 07.1 14.098N 91.015W   82 550MB   600PAS    6.00
ERL 81  07 11 71 05 15 56.1 14.216N 91.857W   86 500MB      0       4.78
NOS 39  19 05 71 13 15 43.1 14.311N 91.982W   86 470MB      0       4.28
GUTE    22 05 32 22 40 02.0 14.250N 90.000W   80   0     600PAS    6.00
CGS 29  22 04 69 00 29 25.0 14.078N 90.954W   89 480MB      0       4.45
ERL 26  29 03 72 15 08 20.6 14.417N 90.777W   82 420MB      0      *3.45
ERL 56  06 08 71 19 52 47.5 14.298N 90.834W   87 460MB      0      *4.12
CGS-B   29 08 65 01 45 54.4 14.000N 90.600W   85 510MB      0       4.95
CGS 85  31 10 68 00 18 11.7 14.007N 90.762W   81 400MB      0       3.12
GUTE    07 09 15 01 20 48.0 14.000N 89.000W   80   0     790PAS    7.90
CGS-B   24 02 65 00 26 45.8 13.700N 92.100W   87 450MB      0       3.95
CGS-B   13 02 63 00 22 51.3 13.900N 91.000W   81 520MB      0       5.11
CGS-B   06 09 65 08 35 05.3 13.500N 91.100W   88 400MB      0       3.12
ERL 39  22 06 72 13 13 13.0 13.881N 91.793W   84 450MB      0      *3.95
ERL 57  05 10 72 10 48 19.1 13.659N 91.073W   89 540MB      0       5.45
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CGSPDE  02 05 74 03 51 50.4 13.800N 90.500W   65 460MB              4.11
CGSPDE  19 08 74 15 11 23.8 14.700N 93.500W   67 440MB              3.78
CGSPDE  30 08 74 07 45 20.9 12.800N 87.400W   62 490MB              4.61
CGSPDE  15 12 75 17 36 29.7 14.387N 92.691W   65 520MB              5.10
CGSPDE  26 01 76 02 17 46.3 13.942N 91.005W   69 510MB              4.94
ERL 45  15 06 73 08 02 23.6 15.040N 93.427W   75 450MB      0     G*3.95
CGS 69  05 10 69 20 35 35.5 15.345N 93.335W   73 420MB      0      *3.45
CGS-B   23 12 65 11 43 03.6 14.700N 92.500W   74 440MB      0       3.79
CGS-B   30 08 66 05 29 47.6 14.500N 92.300W   79 420MB      0       3.45
ERL 39  07 06 73 18 32 42.9 14.277N 92.008W   78 550MB   620PAS    6.20
CGS-B   17 01 66 14 42 19.9 14.100N 92.100W   75 480MB      0       4.45
NOS 15  18 02 71 09 20 20.1 14.488N 92.181W   79 490MB      0       4.62
CGSPDE  10 09 68 23 13 47.0 14.505N 92.936W   72 500MB      0       4.78
CGS-B   10 02 67 22 32 31.6 14.159N 92.537W   77 400MB      0      *3.12
ERL 41  08 06 73 05 37 15.5 14.057N 92.188W   77 420MB      0      *3.45
CGS-B   15 02 64 07 40 38.5 14.100N 92.700W   76 390MB      0       3.00
CGS-B   03 07 63 09 13 30.7 14.500N 92.800W   72 400MB      0       3.12
CGS-B   15 02 66 00 16 53.7 14.500N 91.500W   71 440MB      0       3.79
ERL 41  08 06 73 07 47 38.7 14.115N 91.857W   73 420MB      0      *3.45
CGS 64  13 09 70 13 42 52.7 14.037N 91.542W   70 420MB      0       3.45
ERL 42  07 06 73 18 34 46.3 14.183N 91.899W   70 570MB      0       5.94
ERL 38  09 06 73 00 58 04.0 14.070N 91.852W   76 470MB      0       4.28
ISS     14 11 58 05 46 30.0 14.410N 91.590W   76   0     550TAC    5.50
CGS-B   16 04 65 04 53 02.8 14.000N 91.600W   75 420MB      0       3.45
ERL  7  31 01 72 23 09 10.2 13.848N 91.301W   78 440MB      0      *3.79
ERL 69  07 09 71 08 02 33.5 13.822N 91.194W   74 380MB      0      *3.00
GUTE    20 01 39 20 40 27.0 13.500N 91.500W   70   0     650PAS    6.50
ERL 36  27 06 72 19 39 36.1 13.981N 91.754W   74 510MB      0       4.95
NOS 79  18 11 70 06 58 34.1 13.768N 91.390W   77 490MB      0      *4.62
CGS-B   16 04 65 13 38 59.8 13.700N 91.700W   78 420MB      0       3.45
ERL 44  27 07 72 20 03 52.9 13.317N 90.131W   78 450MB      0       3.95
CGS-B   23 05 67 11 37 16.8 13.889N 90.528W   76 380MB      0      *3.00
CGS-B   07 11 64 20 21 12.1 13.000N 90.100W   73 410MB      0       3.29
CGS-B   02 03 64 18 13 58.5 13.500N 90.500W   73 360MB      0       3.00
CGS-B   16 05 67 15 11 28.5 13.275N 90.939W   75 410MB      0      *3.29
GS  54  21 08 73 12 42 32.5 13.252N 90.564W   70 390MB      0     G*3.00
NOS 41  29 05 71 00 00 53.5 13.653N 90.016W   72 450MB      0       3.95
CGS-B   28 09 64 03 20 59.4 13.500N 90.100W   72 380MB      0       3.00
ERL 42  27 07 72 20 44 20.4 13.276N 90.049W   77 450MB      0       3.95
CGS  5  11 01 69 06 04 23.4 13.586N 90.780W   73 380MB      0      *3.00
ERL 35  11 06 72 19 09 11.6 13.511N 90.521W   79 440MB      0      *3.79
ERL 40  30 06 73 08 08 57.5 13.753N 90.935W   78 510MB      0       4.95
CGS  8  21 01 69 14 48 47.2 13.526N 90.186W   79 410MB      0       3.29
CGS-B   07 08 66 05 33 40.6 13.400N 89.900W   74 440MB      0       3.79
CGSPDE  18 11 67 12 16 55.4 13.400N 89.100W   78 510MB      0       4.95
CGSPDE  18 11 67 12 26 09.4 13.300N 89.300W   70 470MB      0       4.28
ERL 86  26 11 71 14 01 37.5 13.305N 89.140W   79 440MB      0       3.79
CGS 31  25 04 69 16 46 31.5 13.511N 89.174W   70 430MB      0       3.62
CGS 65  10 10 69 04 06 24.1 13.199N 89.717W   71 460MB      0       4.12
CGS-B   21 05 67 03 12 01.0 13.283N 89.694W   71 450MB      0       3.95
CGS 74  16 11 69 10 30 01.7 13.351N 89.650W   79 490MB   488GDL    4.88
CGS-B   22 09 64 13 27 29.7 13.500N 89.700W   78 480MB      0       4.45
CGS-B   08 03 67 15 52 15.8 13.049N 88.127W   75 390MB      0      *3.00
CGS 19  09 03 69 07 12 39.0 13.101N 88.528W   75 440MB      0       3.79
CGSPDE  06 05 68 05 41 26.0 13.218N 88.605W   78 380MB      0      *3.00
GUTE    26 12 39 11 55 11.0 13.250N 88.250W   75   0     600PAS    6.00
CGS-B   09 01 57 22 31 22.1 13.138N 88.981W   78 410MB      0       3.29
CGS-B   04 01 67 00 28 07.5 13.100N 88.625W   72 410MB      0       3.29
CGS-B   27 12 66 21 22 16.5 13.300N 88.800W   78 540MB      0       5.45
CGS 13  15 02 70 07 09 54.0 12.661N 90.219W   70 450MB      0       3.95
CGS-B   25 08 66 12 04 20.3 12.800N 89.300W   73 440MB      0       3.79
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NCS   9 C3 02 71 14 48 41.8 14.332N 91.388W  95 490MB     0         4.62
CGSPDE  25 11 67 04 13 42.8 14.100N 90.500W  96 420MB     0         3.45
CGS  75 C2 10 68 C2 45 58.1 14.207N 90.989W  99 450MB     0         3.95
ERL  23 29 03 73 06 47 08.0 14.028N 90.226W  96 420MB     0         3.45
CGS-B   20 05 67 07 58 15.3 14.001N 90.420W  94 410MB     0         3.29
CGS-B   02 02 65 03 46 36.2 14.300N 90.400W  94 460MB     0         4.12
CGS-B   16 02 65 10 54 39.7 13.400N 91.200W  97 410MB     0         3.29
ERL  35 31 05 73 05 39 18.8 13.941N 90.877W  99 540MB   520BRK      5.20
NOS  75 08 11 70 11 49 36.0 13.333N 90.665W  96 450MB     0         3.95
CGSPDE  29 06 68 06 21 48.1 13.807N 90.220W  97 470MB     0       G 4.28
NOS  30 19 04 71 05 07 48.5 13.907N 90.540W  92 500MB     0         4.78
ERL  42 27 07 72 21 16 44.5 13.210N 90.004W  91 450MB     0        *3.95
CGS-B   16 05 67 12 58 09.2 13.480N 90.639W  92 480MB   570UPP      5.70
CGS  79 14 10 68 21 12 23.6 13.903N 89.719W  90 420MB     0         3.45
CGS-B   25 09 64 01 54 17.6 13.300N 89.400W  94 400MB     0         3.12
CGSPDE  07 05 68 23 39 14.4 13.043N 89.703W  91 460MB     0         4.12
CGS  40 23 05 69 09 18 05.1 13.065N 89.808W  94 420MB     0         3.45
CGS-B   25 05 63 14 52 27.8 13.100N 89.800W  91 420MB     0         3.45
ERL  24 11 04 72 07 33 52.8 13.523N 89.135W  93 450MB     0         3.95
CGS  75 30 09 68 11 26 15.7 13.632N 89.626W  94 440MB     0         3.79
NOS  31 01 05 71 14 32 12.8 13.259N 88.499W  93 540MB     0         5.45
CGS-B   16 03 64 06 06 51.5 13.300N 88.300W  92 390MB     0         3.00
ISS     06 05 51 23 03 32.0 13.000N 87.800W  96   0     625TAC      6.25
GUTE    29 06 19 23 14 23.0 13.300N 86.500W  90   0     675PAS      6.75
CGS-B   28 02 65 06 56 51.7 12.800N 89.700W  97 400MB     0         3.12
GUTE    08 07 39 21 31 44.0 12.300N 88.000W  90   0     550PAS      5.50
CGS-B   14 10 65 10 17 23.9 12.500N 88.300W  96 380MB     0         3.00
CGS-B   09 02 66 06 22 44.5 12.700N 87.800W  98 440MB     0         3.79
CGS-B   20 10 65 23 54 51.3 12.700N 87.000W  91 560MB     0         5.78
CGSPDE  21 03 74 22 01 13.3 13.900N 90.100W  99 430MB               3.62
CGSPDE  02 04 74 20 12 21.1 13.500N 90.300W  91 460MB               4.11
CGSPDE  24 03 75 11 51 03.9 13.000N 89.300W  93 460MB               4.11
CGSPDE  19 06 75 16 12 42.2 13.400N 89.300W  93 500MB               4.77
CGSPDE  08 02 68 06 53 28.1 16.300N 93.500W 100 410MB     0         3.29
CGSPDE  09 05 68 18 03 09.9 16.258N 93.446W 101 510MB     0       D 4.95
TAC     25 09 58 17 47 50.0 15.400N 93.083W 100   0     530TAC      5.30
GUTE    24 08 44 23 37 54.0 16.000N 93.500W 100   0     600PAS      6.00
CGS     22 12 49 09 30 47.0 16.000N 93.000W 100   0     650PAS      6.50
CGS  70 16 09 69 14 25 42.5 15.455N 93.123W 104 500MB     0         4.78
CGS  61 28 08 70 02 31 21.1 15.677N 93.567W 100 430MB     0      G*3.62
CGSPDE  02 06 68 19 29 14.0 15.913N 93.252W 100 450MB     0      G*3.95
ISS     04 12 56 23 01 34.0 15.020N 92.220W 102   0     600PAS      6.00
CGS  90 25 11 68 18 37 58.8 15.871N 92.363W 105 460MB     0       G 4.12
CGS     15 05 59 07 49 30.0 14.000N 93.000W 100   0     520TAC      5.20
TAC     14 12 53 08 45 10.0 14.717N 93.333W 100   0     550TAC      5.50
ERL  45 30 06 73 11 45 56.9 14.947N 93.202W 109 420MB     0        *3.45
CGS  37 23 05 70 16 16 43.8 14.912N 92.227W 109 490MB     0         4.62
CGS  42 05 06 70 09 25 42.9 14.244N 92.249W 102 460MB     0        *4.12
TAC     09 01 56 13 11 38.0 14.533N 92.317W 100   0     580TAC      5.80
TAC     03 09 58 04 18 08.0 14.533N 92.317W 100   0     620TAC      6.20
CGS  50 19 07 69 19 48 50.5 14.595N 92.652W 100 480MB     0         4.45
CGSPDE  24 08 68 08 21 07.2 14.630N 92.195W 109 390MB     0        *3.00
CGSPDE  25 11 67 13 54 24.5 14.500N 92.100W 108 420MB     0         3.45
CGS-B   17 06 61 18 39 51.4 14.600N 92.100W 105   0     530TAC      5.30
ERL  29 23 03 73 05 07 27.5 14.134N 91.086W 100 420MB     0      G*3.45
ERL  33 24 05 73 19 34 13.5 14.710N 91.234W 100 520MB     0       D 5.11
CGS-B   01 05 63 16 38 52.6 14.000N 91.800W 109 410MB     0         3.29
ERL  11 22 02 73 00 30 20.3 14.478N 91.637W 107 520MB     0         5.11
ERL   7 22 01 72 13 08 50.3 14.029N 91.014W 102 550MB   600PAS      6.00
CGS     10 03 60 18 55 55.0 14.500N 91.500W 100   0     540TAC      5.40
CGS     08 07 49 12 40 47.0 14.000N 91.500W 100   0     600PAS      6.00
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ERL  70 18 09 71 17 11 54.7 13.526N 90.026W  82 480MB     0         4.45
ERL  15 11 03 72 03 50 45.9 13.358N 90.042W  85 510MB   560BRK      5.60
ERL  22 09 04 72 15 26 59.9 13.528N 90.464W  85 480MB     0         4.45
CGS  44 16 06 70 01 56 34.9 13.041N 90.678W  87 460MB     0         4.12
CGS  71 23 09 70 22 48 33.5 13.514N 90.086W  80 470MB     0         4.28
CGS-B   20 05 67 07 48 53.0 13.640N 90.555W  89 470MB     0         4.28
CGS  70 23 09 70 22 56 00.1 13.521N 90.078W  83 460MB     0         4.12
ERL  27 20 04 73 09 19 23.4 13.482N 90.028W  88 480MB     0        *4.45
ERL  43 06 08 72 23 06 20.8 13.478N 90.590W  83 460MB     0         4.12
CGS  63 01 09 70 01 03 41.2 13.077N 89.350W  80 420MB     0        *3.45
CGS-B   24 06 61 05 07 55.6 13.400N 89.900W  81   0     488PAL      4.88
CGS-B   07 11 64 20 07 04.4 13.100N 89.900W  82 430MB     0         3.62
NOS  37 28 05 71 03 09 04.1 13.049N 89.963W  86 430MB     0         3.62
SSS     24 08 61 06 30 35.0 13.500N 89.600W  80   0     450SSS      4.50
CGS-B   09 04 64 04 15 23.0 13.500N 89.900W  89 500MB     0         4.78
CGS-B   19 05 67 07 52 03.9 13.241N 89.518W  89 510MB     0         4.95
ERL  27 17 04 72 19 25 59.7 13.514N 89.590W  88 430MB     0         3.62
NOS  39 28 05 71 20 19 25.7 13.732N 89.753W  84 440MB     0        *3.79
CGS-B   13 03 67 08 37 11.7 13.726N 88.069W  82 380MB     0        *3.00
GUTE    16 11 41 09 39 46.0 13.250N 88.500W  80   0     575PAS      5.75
CGS-B   20 09 56 03 53 34.1 13.100N 88.200W  81 400MB     0         3.12
CGS-B   13 11 64 08 02 38.5 13.000N 88.600W  86 490MB     0         4.62
ERL  11 17 02 72 09 19 06.4 13.259N 88.691W  80 470MB     0         4.28
CGS-B   24 02 64 02 29 12.5 13.000N 87.200W  83 390MB     0         3.00
CGS-B   20 07 64 08 27 26.0 13.000N 87.900W  87 380MB     0         3.00
CGS-B   13 04 67 06 10 00.9 12.778N 89.141W  84 440MB     0         3.79
GUTE    20 06 32 09 01 47.0 12.500N 89.000W  80   0     600PAS      6.00
CGS-B   05 07 63 14 40 54.7 12.600N 88.900W  85 410MB     0         3.29
CGS-B   23 12 66 02 02 19.8 12.900N 88.600W  88 450MB     0         3.95
CGSPDE  06 12 67 02 53 06.9 12.500N 87.200W  87 530MB     0         5.28
CGS  48 26 07 69 07 21 00.2 12.625N 87.798W  84 480MB     0         4.45
CGS-B   18 04 67 13 05 15.6 12.765N 87.943W  84 390MB     0        *3.00
CGSPDE  08 12 73 00 55 11.5 13.300N 89.900W  88 490MB               4.61
CGSPDE  04 03 74 14 54 36.1 13.600N 90.600W  89 450MB               3.95
CGSPDE  05 03 74 15 10 24.1 13.200N 90.800W  84 430MB               3.62
CGSPDE  12 09 74 20 14 37.3 13.600N 89.900W  85 500MB               4.77
CGSPDE  01 01 75 22 52 36.4 14.100N 91.900W  80 500MB               4.77
CGSPDE  31 08 75 13 19 03.7 14.100N 90.600W  88 450MB               3.95
ERL  49 11 08 72 10 54 49.8 16.130N 93.491W  98 450MB     0      D*3.95
CGS-B   07 07 64 22 14 01.8 15.200N 93.200W  90 410MB     0         3.29
ERL  32 23 05 72 00 37 45.2 15.141N 93.013W  96 460MB     0         4.12
CGS-B   09 05 67 17 18 10.2 15.281N 93.014W  98 370MB     0        *3.00
CGS  41 11 06 70 09 26 02.1 15.545N 92.770W  92 490MB     0       D 4.62
CGS-B   01 03 65 21 32 11.8 15.400N 92.500W  93 590MB     0         6.28
CGS-B   02 03 61 00 04 12.7 15.800N 92.200W  98   0     575MAT      5.75
CGS-B   23 12 65 07 56 11.0 14.500N 92.500W  94 390MB     0         3.00
CGSPDE  24 06 67 07 51 46.5 14.500N 92.600W  91 460MB     0         4.12
CGS  71 27 10 69 10 23 29.5 14.429N 92.309W  96 430MB     C         3.62
CGS-B   28 06 54 07 19 18.6 14.100N 92.000W  98 370MB     0         3.00
CGS-B   22 06 66 07 11 01.7 14.700N 92.000W  93 480MB     0         4.45
ERL  47 28 06 71 02 44 07.7 14.445N 91.611W  97 500MB     0         4.78
CGS-B   14 04 67 04 25 10.4 14.217N 91.772W  99 410MB     0         3.29
CGSPDE  06 04 68 03 32 29.2 14.100N 91.500W  93 410MB     0         3.29
CGS   8 28 01 70 04 47 05.2 14.159N 91.597W  92 500MB     0         4.78
CGS-B   18 01 67 07 48 18.3 14.945N 91.893W  93 410MB     0         3.29
CGS-B   03 02 63 04 23 18.0 14.500N 91.900W  91 460MB     0         4.12
ISS     24 08 53 13 21 02.0 14.100N 91.400W  96   0     650PAS      6.50
GUTE    27 07 40 13 32 30.0 14.250N 91.500W  90   0     675PAS      6.75
ERL  38 07 06 73 19 45 43.0 14.356N 91.951W  97 510MB     0         4.95
CGS-B   20 04 65 12 44 58.1 14.500N 91.800W  96 390MB     0         3.00
ERL  41 10 06 73 17 35 53.9 14.203N 91.402W  92 460MB     0        *4.12
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CGS 45 23 06 69 02 38 57.3 15.177N 92.369W 112 400MB      0      3.12
CGSPDE 28 03 68 01 07 37.6 15.100N 92.100W 111 520MB      0      5.11
GUTE   28 09 39 14 58 27.0 15.500N 91.500W 110   0     625PAS    6.25
GUTE   23 09 43 15 00 44.0 15.000N 91.500W 110   0     675PAS    6.75
GUTE   17 03 35 21 33 18.0 14.500N 92.000W 110   0     575PAS    5.75
CGS 95 23 11 68 11 41 00.2 14.433N 92.212W 115 420MB      0     *3.45
CGS    14 11 60 19 59 35.2 14.900N 92.800W 114   0     513PAS    5.13
CGS-B  11 08 65 02 54 48.4 14.700N 92.900W 111 440MB      0      3.79
CGS-B  24 02 63 13 34 14.7 14.700N 91.300W 119 560MB      0      5.78
CGS-B  06 07 64 05 53 43.7 14.100N 91.200W 119 370MB      0      3.00
CGS-B  05 04 64 05 30 12.6 14.200N 91.600W 111 400MB      0      3.12
CGS    20 08 60 00 19 35.2 14.500N 91.500W 115   0     600PAS    6.00
CGS  5 14 01 69 20 08 09.3 14.903N 91.231W 113 410MB      0     *3.29
CGS-B  05 05 63 12 44 43.0 14.300N 91.900W 112 420MB      0      3.45
ERL 57 30 09 72 11 15 23.0 14.336N 91.366W 119 440MB      0     *3.79
CGS-B  15 12 64 12 13 25.8 14.700N 91.700W 118 540MB      0      5.45
CGS 60 29 08 69 13 53 08.5 14.465N 90.989W 118 430MB      0      3.62
ERL 15 09 03 73 09 58 09.2 15.621N 91.266W 114 470MB      0      4.28
CGS-B  21 03 67 09 55 19.9 15.924N 90.955W 112 400MB      0      3.12
ERL 50 21 08 72 23 33 50.0 15.957N 90.816W 119 480MB      0      4.45
CGS 96 08 12 68 03 12 29.1 15.924N 90.594W 116 410MB      0     *3.29
ERL 84 16 11 71 00 26 51.5 15.412N 90.729W 115 460MB      0     *4.12
CGS 73 12 11 69 03 48 28.2 13.668N 89.984W 111 400MB      0      3.12
CGS-B  24 12 65 22 57 16.3 12.000N 89.000W 118 450MB      0      3.95
CGS-B  28 08 63 05 55 51.3 12.000N 87.200W 115 420MB      0      3.45
CGS-B  30 04 67 03 10 49.4 12.532N 86.852W 115 420MB      0      3.45
CGSPDE 02 11 73 03 06 56.6 13.200N 88.000W 118 450MB             3.95
CGSPDE 06 11 73 01 02 40.3 14.400N 91.400W 111 470MB             4.28
CGSPDE 05 12 73 04 01 50.3 14.700N 91.800W 115 490MB             4.61
CGSPDE 04 05 74 17 49 28.8 15.900N 90.500W 115 450MB             3.95
CGSPDE 01 09 74 13 49 38.5 13.500N 88.900W 111 490MB             4.61
ERL 28 27 04 73 04 58 06.0 15.416N 92.696W 126 470MB      0      4.28
NOS 81 29 11 70 20 00 56.2 15.311N 92.749W 124 510MB      0      4.95
CGS-B  27 08 65 07 51 34.2 15.100N 92.700W 128 410MB      0      3.29
CGS-B  13 07 65 00 36 31.5 15.500N 92.000W 123 500MB      0      4.78
GUTE   04 02 21 08 22 44.0 15.000N 91.000W 120   0     750PAS    7.50
CGSPDE 26 09 67 12 14 34.9 15.000N 91.300W 122 400MB      0      3.12
CGS    17 10 60 22 15 32.0 14.700N 92.800W 128   0     588PAL    5.88
ERL 39 13 06 72 19 44 35.3 14.446N 92.826W 127 440MB      0     *3.79
NOS 81 06 12 70 18 56 30.6 14.626N 91.967W 128 430MB      0     *3.62
CGS-B  27 02 66 05 39 38.6 14.100N 91.200W 129 400MB      0      3.12
GUTE   19 05 34 10 47 37.0 14.750N 91.250W 120   0     625PAS    6.25
CGS-B  14 04 64 02 42 04.9 14.100N 91.300W 126 390MB      0      3.00
NOS 36 28 05 71 14 12 07.9 14.534N 91.405W 124 540MB      0    D 5.45
CGS-B  19 01 65 09 14 36.6 14.500N 91.700W 121 430MB      0      3.62
CGSPDE 06 05 68 14 37 49.8 14.641N 90.821W 123 510MB      0      4.95
NOS 29 14 04 71 03 09 09.1 14.125N 90.133W 124 480MB      0      4.45
CGS 77 15 11 69 16 40 21.5 14.575N 90.405W 121 390MB      0     *3.00
CGS-B  01 11 63 11 34 55.9 15.500N 90.100W 128 440MB      0      3.79
CGS-B  04 05 63 16 19 27.4 15.000N 90.900W 123 470MB      0      4.28
CGS-B  29 05 67 01 43 54.7 13.791N 89.686W 123 420MB      0      3.45
CGS-B  12 04 61 22 20 33.6 13.200N 88.900W 122   0     588PAS    5.88
CGS-B  13 03 64 11 54 06.1 12.900N 90.400W 128 490MB      0      4.62
CGS 41 15 06 69 19 29 45.9 12.665N 90.135W 128 430MB      0     *3.62
CGS-B  20 03 64 06 35 51.6 12.900N 89.900W 125 420MB      0      3.45
CGSPDE 07 03 74 20 11 50.3 14.900N 91.500W 121 450MB             3.95
CGSPDE 25 10 74 00 05 34.1 15.800N 93.100W 120 550MB             5.60
NOS 38 23 05 71 08 23 41.5 15.264N 92.861W 130 470MB      0    G*4.28
CGS-B  24 07 62 21 08 22.1 15.400N 92.500W 131   0     550BRK    5.50
CGS-B  17 08 65 14 02 19.2 15.000N 92.100W 137 500MB      0      4.78
CGSPDE 25 09 68 10 38 38.4 15.571N 92.638W 138 570MB   D  0      5.94

NOS 44 13 06 71 03 54 26.8 14.234N 91.300W 104 430MB      0     *3.62
CGS-B  09 03 67 14 08 44.8 14.537N 91.473W 102 470MB      0      4.28
CGS 66 15 10 69 11 54 13.9 14.520N 90.994W 105 440MB      0      3.79
ERL 12 22 02 73 07 38 01.1 14.504N 90.977W 100 460MB      0     *4.12
CGSPDE 17 06 67 17 43 55.2 14.100N 90.000W 103 480MB      0      4.45
CGS 12 18 01 70 23 43 10.5 14.165N 90.929W 106 430MB      0     *3.62
CGSPDE 23 08 67 19 02 27.6 15.500N 92.000W 109 440MB      0      3.79
CGS-B  25 06 66 17 24 39.2 15.900N 91.100W 103 510MB      0      4.95
CGS-B  08 05 67 00 59 51.0 15.599N 91.296W 100 370MB      0     *3.00
ERL  5 22 01 72 22 52 14.1 15.896N 91.064W 106 450MB      0     *3.95
CGS    13 09 60 17 51 08.9 15.600N 90.500W 104   0     425PAS    4.25
CGS 70 13 10 70 23 21 42.5 15.764N 90.046W 100 480MB      0      4.45
ERL 39 05 07 72 13 00 18.6 15.951N 90.526W 109 480MB      0      4.45
CGS-B  14 10 65 08 30 03.3 15.200N 90.800W 106 370MB      0      3.00
ERL  6 25 01 73 22 25 59.5 13.700N 89.324W 100 440MB      0      3.79
CGS-B  04 04 66 19 50 07.1 13.800N 89.700W 102 510MB      0      4.95
CGS 31 04 04 69 08 43 06.4 13.534N 88.981W 105 430MB      0     *3.62
GUTE   07 02 31 03 30 35.0 13.000N 87.000W 100   0     575PAS    5.75
CGS-B  12 04 66 03 34 22.4 12.000N 87.600W 104 390MB      0      3.00
CGS    03 05 59 04 41 24.0 12.500N 87.500W 100   0     560TAC    5.60
CGSPDE 17 01 74 11 16 02.8 13.200N 88.300W 103 460MB             4.11
CGSPDE 09 02 74 18 36 06.0 14.700N 91.900W 109 480MB             4.44
CGSPDE 10 04 74 22 43 00.6 14.500N 91.600W 108 540MB             5.43
CGSPDE 12 10 74 05 32 39.6 14.500N 91.400W 105 410MB             3.29
CGSPDE 01 01 75 23 41 22.0 14.200N 91.800W 108 440MB             3.78
CGSPDE 11 01 75 18 07 44.4 14.500N 91.400W 104 460MB             4.11
CGSPDE 21 01 75 00 36 11.5 14.400N 92.100W 106 440MB             3.78
CGSPDE 14 04 75 23 17 43.1 15.000N 90.200W 107 430MB             3.62
CGSPDE 21 09 75 15 55 27.2 14.100N 91.000W 102 480MB             4.44
CGSPDE 30 09 75 15 35 24.4 14.300N 91.000W 107 480MB             4.44
CGSPDE 25 01 76 10 59 48.4 15.932N 90.883W 103 500MB             4.77
GUTE   28 06 44 07 58 54.0 15.000N 92.500W   0   0     700PAS    7.00
CGS    24 01 59 19 42 20.0 15.000N 92.500W   0   0     625PAS    6.25
GUTE   17 04 19 20 53 03.0 14.500N 91.750W   0   0     700PAS    7.00
GUTE   26 09 31 20 03 07.0 14.500N 91.500W   0   0     625PAS    6.25
GUTE   06 08 42 23 36 59.0 14.000N 91.000W   0   0     830PAS    8.30
GUTE   08 08 42 22 36 34.0 14.250N 91.500W   0   0     650PAS    6.50
CFR    19 04 02 02 23 00.0 14.000N 91.000W  25   0     830PAS A  8.30
CGS-B  13 12 66 05 17 29.4 15.500N 93.200W  42 380MB      0      3.00
CGS-B  04 05 67 04 00 17.1 15.524N 93.194W  48 390MB      0     *3.00
CGS-B  14 10 64 21 05 07.0 15.500N 93.000W  44 400MB      0      3.12
GUTE   24 04 35 18 51 40.0 15.250N 93.000W  50   0     625PAS    6.25

****   S16 - F5  BENIOFF
CGS-B  23 02 65 00 08 41.1 15.100N 93.400W  33 410MB      0      3.29
CFR    23 09 02 20 18 00.0 16.000N 93.000W  25   0     840PAS A  8.40
CGS-B  03 05 66 12 45 30.3 15.900N 92.900W  53 430MB      0      3.62
CGS-B  11 01 65 04 10 04.4 14.000N 89.500W 144 500MB      0      4.78
CGSPDE 14 07 67 18 02 08.1 13.500N 88.800W 147 460MB      0      4.12
CGS-B  17 09 63 03 48 09.7 12.600N 87.100W 144 390MB      0      3.00
NOS 41 11 06 71 11 51 40.1 12.647N 86.957W 148 450MB      0     *3.95
CGSPDE 09 11 73 02 36 55.5 14.000N 89.600W 149 490MB             4.61
CGSPDE 20 02 75 03 23 54.6 14.500N 91.100W 143 460MB             4.11
CGSPDE 04 04 75 14 36 57.4 14.400N 91.400W 143 420MB             3.45
NOS 83 24 12 70 08 00 37.6 16.102N 93.564W 116 560MB     525BRK    5.25
GUTE   12 01 45 21 59 29.0 16.000N 93.000W 110   0     575PAS    5.75
ERL 32 04 05 72 06 26 40.5 15.990N 93.083W 113 510MB      0      4.95
CGS-B  26 08 66 08 42 37.5 15.400N 93.500W 112 400MB      0      3.12
CGS 72 06 11 69 13 13 56.5 15.735N 93.507W 114 460MB      0      4.12
CGSPDE 21 06 68 01 24 53.9 15.378N 92.091W 115 450MB      0    D 3.95
CGSPDE 18 01 68 08 42 48.9 15.700N 92.700W 111 380MB      0      3.00
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CGS 85  26 10 68 14 31 02.0 15.549N 92.035W 199 410MB        0      3.29
CGSPDE  12 10 67 03 17 27.9 14.400N 90.400W 190 390MB        0      3.00
ERL 86  23 11 71 10 24 31.9 14.412N 90.171W 190 460MB        0     *4.12
CGS 25  24 03 70 08 24 45.9 14.443N 90.324W 197 420MB        0      3.45
CGSPDE  11 01 68 20 48 59.1 14.500N 89.900W 197 440MB        0      3.79
CGS 68  06 10 70 15 18 54.9 15.561N 88.312W 192 460MB        0     *4.12
CGSPDE  11 06 68 05 52 33.5 13.941N 88.761W 199 530MB        0    D 5.28
ERL 49  27 07 73 19 42 47.9 12.513N 86.674W 199 530MB        0    D 5.28
CGSPDE  27 11 75 08 43 52.9 12.597N 87.368W 191 430MB               3.62

****  S18 - B7  BENIOFF
CGS-B   07 02 64 11 57 19.1 17.200N 93.000W 245 370MB        0      3.00
GUTE    27 06 41 17 11 44.0 17.750N 92.250W 220   0     625PAS      6.25
GUTE    08 06 37 22 29 39.0 16.000N 93.000W 200   0     625PAS      6.25
TAC     25 06 59 00 48 24.0 16.250N 93.517W 200   0     530TAC      5.30
CGS     09 01 56 17 01 23.0 15.000N 92.000W 200   0     580TAC      5.80
CGS-B   23 12 65 11 13 26.0 16.100N 92.700W 243 400MB        0      3.12
CGS-B   09 10 65 09 37 07.5 16.000N 91.600W 211 450MB        0      3.95
CGS-B   13 09 64 11 52 18.7 15.500N 91.800W 234 380MB        0      3.00
CGS     26 09 55 08 28 20.0 15.500N 92.500W 200   0     687PAS      6.87
CGS-B   24 02 65 21 09 12.2 15.300N 92.200W 262 420MB        0      3.45
CGS-B   21 06 63 04 02 53.7 15.000N 91.700W 219 440MB        0      3.79
ERL 66  17 11 72 14 55 45.2 15.614N 91.462W 222 520MB        0    D 5.11
GUTE    12 12 39 02 50 12.0 15.500N 91.750W 240   0     550PAS      5.50
GUTE    27 10 45 11 24 41.0 15.000N 91.250W 200   0     675PAS      6.75
GUTE    05 01 46 01 15 11.0 15.000N 91.000W 210   0     600PAS      6.00
ERL 92  15 12 71 22 04 19.9 15.047N 91.088W 264 470MB        0      4.28
CGS-B   17 04 67 04 27 48.6 15.196N 90.023W 205 450MB        0      3.95
CGS-B   07 08 63 09 35 38.2 14.600N 91.300W 245 390MB        0      3.00
NOS 81  16 11 70 06 17 54.1 14.277N 90.188W 204 460MB        0      4.12
CGS 38  29 05 69 20 25 56.2 14.722N 90.595W 218 480MB        0      4.45
CGS-B   16 04 64 11 20 25.2 14.000N 90.000W 209 370MB        0      3.00
CGS-B   28 07 65 13 20 14.5 14.500N 90.300W 220 430MB        0      3.62
CGS-B   14 12 65 14 21 05.9 14.500N 89.700W 273 490MB        0      4.62
CGS-B   01 07 66 20 17 49.2 13.700N 88.400W 201 460MB        0      4.12
CGS-B   09 12 64 14 22 03.1 13.200N 87.200W 200 390MB        0      3.00
ERL 45  28 07 72 13 53 40.1 13.131N 87.753W 209 440MB        0     *3.79
CGS-B   25 07 66 00 42 58.9 13.200N 87.800W 210 400MB        0      3.12
ERL 60  12 08 71 05 59 00.1 12.877N 87.341W 211 470MB        0      4.28
CGS-B   19 01 67 02 19 23.1 12.561N 86.613W 200 450MB        0    G 3.95
GUTE    24 02 34 05 33 30.0 12.750N 86.750W 200   0     600PAS      6.00
CGSPDE  10 11 73 19 46 26.8 14.500N 90.200W 243 460MB               4.11
CGSPDE  28 11 73 06 45 06.3 14.500N 90.000W 230 500MB               4.77
CGSPDE  23 10 74 13 36 51.8 14.700N 90.600W 231 460MB               4.11
CGSPDE  01 02 75 09 36 44.9 15.100N 92.600W 237 430MB               3.62
CGSPDE  03 02 75 01 03 25.2 15.600N 91.800W 218 540MB               5.43
CGSPDE  13 08 75 23 07 43.5 14.500N 89.900W 256 470MB               4.28
CGSPDE  30 09 75 19 01 25.7 16.200N 91.500W 298 430MB               3.62
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CGS-B   14 09 63 09 43 52.0 15.600N 91.000W 130 410MB        0      3.29
CGS     16 10 60 09 34 44.7 14.000N 91.200W 135   0     500PAL      5.00
CGS-B   13 12 63 19 57 27.4 14.500N 91.900W 139 400MB        0      3.12
ERL 28  04 05 73 00 30 30.2 14.925N 91.161W 131 410MB        0     *3.29
CGS-B   15 02 66 14 54 42.9 14.500N 91.100W 137 390MB        0      3.00
CGS-B   26 07 65 13 06 10.5 14.900N 90.900W 133 380MB        0      3.00
CGS-B   02 03 64 12 39 17.6 13.900N 91.100W 130 460MB        0      4.12
CGS-B   29 05 63 22 41 36.7 13.900N 91.800W 131 440MB        0      3.79
CGS-B   24 02 67 09 16 41.8 13.437N 90.117W 135 430MB        0     *3.62
CGS-B   23 05 61 16 44 59.4 12.700N 87.300W 138   0    F650PAS      6.50
CGSPDE  14 04 74 06 55 01.6 14.700N 91.300W 138 530MB               5.27
CGSPDE  07 01 75 21 10 14.6 13.400N 93.500W 139 450MB               3.95
CGSPDE  25 01 76 03 37 29.4 14.750N 91.872W 139 490MB               4.61
NOS 32  03 05 71 08 09 49.6 15.536N 93.495W 149 430MB        0     *3.62
CGSPDE  03 02 68 15 40 44.5 16.500N 93.500W 142 550MB        0      5.61
CGS 72  06 11 69 13 01 20.1 15.650N 92.494W 141 500MB        0      4.78
CGS-B   06 05 67 12 39 45.5 15.507N 92.398W 144 430MB        0      3.62
GUTE    11 04 42 01 25 12.0 14.750N 91.500W 140   0     650PAS      6.50
CGS-B   14 06 63 07 23 13.7 15.500N 93.500W 150 400MB        0      3.12
CGS 77  25 09 68 22 15 03.9 15.601N 92.023W 155 420MB        0     *3.45
CGS-B   26 02 66 07 54 35.5 15.500N 92.200W 152 490MB        0      4.62
CGS-B   26 05 61 05 06 31.9 15.400N 91.800W 150   0     538MAT      5.38
CGSPDE  23 06 68 06 24 52.6 14.310N 92.253W 157 380MB        0     *3.00
CGS 50  22 07 69 15 51 46.5 14.162N 91.476W 151 470MB        0      4.28
CGS     08 07 57 15 30 33.0 14.500N 91.000W 150   0    F600BRK      6.00
CGS-B   26 10 65 14 58 55.1 15.900N 91.400W 155 430MB        0      3.62
CGS 95  16 12 68 09 18 51.1 15.517N 90.077W 156 450MB        0     *3.95
ERL 17  11 03 72 01 41 33.1 13.203N 89.825W 157 390MB        0     *3.00
CGS-B   24 04 64 14 40 28.3 13.300N 88.800W 158 510MB        0      4.95
CGSPDE  20 08 68 00 34 04.0 13.105N 87.833W 157 430MB        0      3.62
CGS-B   16 12 65 05 23 06.3 12.600N 88.800W 152 440MB        0      3.79
CGSPDE  24 12 74 02 10 25.4 14.500N 90.100W 155 540MB               5.43
CGSPDE  14 03 75 06 04 31.3 16.000N 93.400W 155 550MB               5.60

****  S17 - B6  BENIOFF
CGS-B   12 02 66 08 36 36.5 16.100N 91.700W 167 390MB        0      3.00
CGSPDE  14 05 68 20 44 38.0 15.389N 92.791W 160 460MB        0    G*4.12
CGSPDE  21 01 68 23 44 46.1 15.600N 92.300W 166 500MB        0      4.78
CGS-B   23 01 65 05 47 31.8 15.100N 91.800W 166 410MB        0      3.29
ISS     15 05 52 18 44 13.0 14.500N 92.300W 160   0     563PAS      5.63
ISS     16 05 52 05 42 27.0 14.500N 92.300W 160   0     575PAS      5.75
CGS-B   15 08 65 04 12 56.0 14.500N 92.300W 168 410MB        0      3.29
CGS 77  18 11 69 13 52 40.2 14.521N 92.871W 160 480MB        0    G 4.45
GUTE    02 10 44 17 22 00.0 14.500N 89.750W 160   0     650PAS      6.50
CGS 74  15 09 68 04 32 04.2 13.466N 87.243W 164 390MB        0     *3.00
CGSPDE  17 10 74 19 54 50.3 14.400N 91.100W 160 440MB               3.78
GUTE    22 02 46 17 24 52.0 16.250N 92.500W 170   0     600PAS      6.00
CGS 48  21 07 69 09 05 38.1 15.137N 92.093W 175 470MB        0    G 4.28
ISS     09 03 59 22 03 03.0 15.090N 90.970W 171   0     630TAC      6.30
CGS-B   02 07 63 22 00 48.9 15.700N 88.900W 173 410MB        0      3.29
NOS 16  19 02 71 16 59 40.3 13.532N 88.795W 176 520MB        0    D 5.11
CGS 51  17 07 69 13 24 22.9 12.590N 87.006W 175 440MB        0    G 3.79
CGS 21  14 03 69 08 47 16.3 12.916N 86.755W 178 560MB   580PAS  D 5.80
CGSPDE  10 02 75 03 59 06.9 15.100N 88.600W 179 460MB               4.11
CGS-B   27 08 63 02 29 51.4 17.500N 92.600W 180 360MB        0      3.00
ERL 85  09 11 71 21 50 02.1 16.102N 93.205W 189 440MB        0     *3.79
ERL 92  24 12 71 08 47 41.0 15.514N 92.123W 182 440MB        0      3.79
CGS 22  27 03 70 18 39 18.9 12.631N 86.823W 182 510MB        0      4.95
CGSPDE  23 04 74 11 41 40.9 15.000N 91.700W 180 480MB               4.44
CGSPDE  28 12 74 23 49 51.0 15.000N 91.100W 186 460MB               4.11
CGS-B   20 08 63 09 25 38.9 16.500N 92.400W 193 420MB        0      3.45
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APPENDIX E

COMPUTER PROGRAMS

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C      **************************************************************
C      PROGRAM GENER.MAG                              STANFORD UNIVERSITY
C      **************************************************************
C      THIS PROGRAM REPLACES THE LETTERS EARTHQUAKE RICHTER MAGNITUDES
C      A,B,C,D,E (FROM THE DAMES & MOORE NICARAGUA EARTHQUAKE CATALOG)
C      BY A RICHTER MAGNITUDE OBTAINED THROUGH RANDOM NUMBER GENERATION.
C      **************************************************************
C      INPUT FORMAT
C      ************
C
C       COL     VARIABLE NAME      VARIABLE DESCRIPTION
C
C      1.- EARTHQUAKE RECORD CARD   1 CARD PER RECORD   (10A4)
C       1-36    XMAG(1-9)          COL 1/36 READ IN A FORMAT
C      37-40    XMAG(10)           LETTER EARTHQUAKE MAGNITUDE
C
C      OUTPUT
C      ******
C       THE OUTPUT IS SAVED ON DISK, IT CONTAINS THE SAME INFORMATION AS
C      THE INPUT, BUT THE LETTER MAGNITUDE HAS BEEN REPLACED BY THE
C      RICHTER MAGNITUDE.
C
C      **************************************************************
       DATA B,C,D,E/'   B','   C','   D','   E'/
       DIMENSION XMAG(10)
C      **************************************************************
C
       IY=1
       CALL RANDK(IY,YFL,0)
       DO 100 I=1,1000
       READ(5,1000,END=99)XMAG
  1000 FORMAT(10A4)
       CALL RANDK(IY,YFL,0)
C
       IF(XMAG(9).EQ.E) GO TO 110
       IF(XMAG(9).EQ.D) GO TO 120
       IF(XMAG(9).EQ.C) GO TO 130
       IF(XMAG(9).EQ.B) GO TO 140
C
       WRITE(10,2000)XMAG,XMAG(9)
  2000 FORMAT(10A4,31X,A4)
       GO TO 100
C
   110 MAG=(3.5+YFL*1.8)*100.
       GO TO 109
C
   120 MAG=(5.3+YFL*.7)*100.
       GO TO 109
C
   130 MAG=(6.0+YFL)*100.
       GO TO 109
C
   140 MAG=(7.0+YFL*.7)*100.
   109 WRITE(10,2020)XMAG,MAG
  2020 FORMAT(10A4,31X,I4)
   100 CONTINUE
    99 RETURN
       END
       SUBROUTINE RANDK (IY,YFL,INDEX)
C
C      THIS SUBROUTINE GENERATES RANDOM NUMBERS
C
       IY=IY*314159269+453806245
     4 IF(IY.GE.0) GO TO 6
     5 IY=IY+2147483647+1
     6 CONTINUE
       IF(INDEX.GT.0) GO TO 8
       YFL=FLOAT(IY)*.4656613E-9
     8 RETURN
       END
$DATA
```

```
C       ****************************************************************
C       PROGRAM SORT.DEPTH                                 STANFORD UNIVERSITY
C       ****************************************************************
C       THIS PROGRAM SORTS EARTHQUAKES BY DEPTH.  THE BAND THICKNESS IS SET
C       SET TO 10 KM.
C       ****************************************************************
C       INPUT FORMAT
C       ************
C       THE DATA IS READ FROM DISK.  ONE CARD PER EVENT.  (8A4,I3,11A4)
C
C        COL       VARIABLE NAME      VARIABLE DESCRIPTION
C
C        1-32      XIN1               COL 1/32 READ IN A FORMAT
C       33-35      NDP                DEPTH OF HYPOCENTER
C       36-79      XIN3               COL 36/79 READ IN A FORMAT
C
C       OUTPUT
C       ******
C       THE OUTPUT IS SAVED ON DISK AND CONTAINS THE DATA SORTED BY
C       BANDWITH OF 10 KM STARTING AT DEPTH 0
C
C       ****************************************************************
        DIMENSION XINF1(21,180,8),NDEP(21,180)
       *, XINF3(21,180,11),IND(21),XIN1(8),XIN3(11)
C       ****************************************************************
C
        DO 130 I=1,21
    130 IND(I)=0
C
    100 READ(5,1000,END=99)XIN1,NDP,XIN3
   1000 FORMAT(8A4,I3,11A4)
        N=(NDP/10)+1
        IF(N.GT.21)N=21
        IND(N)=IND(N)+1
        NED=IND(N)
        NDEP(N,NED)=NDP
        DO 400 J=1,8
    400 XINF1(N,NED,J)=XIN1(J)
        DO 500 J=1,11
    500 XINF3(N,NED,J)=XIN3(J)
        GO TO 100
C
     99 CONTINUE
        DO 200 N=1,21
        NDP=(N-1)*10
        NED=IND(N)
        IF(NED.EQ.0) GO TO 210
        WRITE(11,2010) NED,NDP
   2010 FORMAT(I5, 'EQ AT DEPTH 'I5,'  PLUS')
        PRINT,NED,'  EQ AT DEPTH',NDP,'  PLUS'
        DO 220 I=1,NED
        WRITE(11,2000)(XINF1(N,I,J),J=1,8),NDEP(N,I),
       1   (XINF3(N,I,J),J=1,11)
   2000 FORMAT(' '8A4,I3,11A4)
    220 CONTINUE
        PRINT,'    '
        PRINT,'     '
        GO TO 200
    210 PRINT,'NO EQ AT DEPTH',NDP,'  PLUS'
C
    200 CONTINUE
        RETURN
        END
$DATA
```

```
C     ******************************************************************
C     PROGRAM LOCATE.LINE                              STANFORD UNIVERSITY
C     ******************************************************************
C     THIS PROGRAM FITS A LINE THROUGH A SET OF POINTS IN A PLANE USING
C     REGRESSION ANALYSIS.  IT IS USED TO LOCATE A SEISMIC LINE SOURCE
C     GIVEN A NUMBER OF EPICENTERS.
C     ******************************************************************
C     INPUT FORMAT
C     ************
C
C      COL     VARIABLE NAME     VARIABLE DESCRIPTION
C
C     1.- NUMBER OF SOURCES   1 CARD   (I5)
C      1- 5    NBST              NB OF SOURCES TO BE LOCATED
C
C     2.- SOURCE IDENTIFICATION   1 CARD   (I5,18A4)
C      1- 5    NBRC              NB OF RECCORDS IN THE SOURCE
C      6-77    HED1              IDENTIFICATION OF THE SOURCE
C
C     3.- RECORD CARDS   NBRC CARDS   (4F10.0)
C      1-10    Y( )              LATITUDE OF THE EPICENTER
C     11-20    X( )              LONGITUDE OF THE EPICENTER
C     21-30    D( )              DEPTH OF THE HYPOCENTER
C     31-40    XM( )             RICHTER MAGNITUDE
C
C     REPEAT CARDS 2/3 NBST TIMES FOR THE NBST SOURCES
C
C     OUTPUT
C     ******
C     THE OUTPUT DISPLAYS THE SOURCE IDENTIFICATION, THE NUMBER OF
C     RECORDS FOR IN THE SOURCE, THE COORDINATES OF THE CENTROID
C     OF THE DATA AS WELL AS THE SLOPE AND THE DEPTH OF THE LINE.
C
C     ******************************************************************
      IMPLICIT REAL*8 (A-H,C-Z)
      DIMENSION HED1(18),X( 200),Y(200),D( 200),XM(200)
      REAL*4 HED1
C     ******************************************************************
C
      READ(5,1000)NBST
      DO 100 IS=1,NBST
      XB=0.D0
      YB=0.D0
      DB=0.D0
      Y2=0.D0
      X2=0.D0
      XY=0.D0
      XT=0.D0
      YT=0.D0
      XYT=0.D0
      READ(5,1000)NBRC,HED1
 1000 FORMAT(I5,18A4)
      WRITE(6,2000)NBRC,HED1
 2000 FORMAT('0NUMBER OF RECORDS',I6,3X,18A4)
      NBZE=0
      DO 110 IR=1,NBRC
      READ(5,1010)Y(IR),X(IR),D(IR),XM(IR)
 1010 FORMAT(19X,F5.3,3X,F5.3,14X,F3.0,25X,F3.2)
      X(IR)=-X(IR)
      XB=XB+X(IR)
      YB=YB+Y(IR)
      DB=DB+D(IR)
      IF(D(IR).EQ.0.0)NBZE=NBZE+1
      Y2=Y2+Y(IR)*Y(IR)
      X2=X2+X(IR)*X(IR)
      XY=XY+X(IR)*Y(IR)
  110 CONTINUE
      XNBRC1=NBRC-NBZE
      XNBRC=NBRC
      XB=XB/XNBRC
      YB=YB/XNBRC
      DB=DB/XNBRC1
      ALPH=(XY-XNBRC*XB*YB)/(X2-XNBRC*XB*XB)
      ALPH1=(XY-XNBRC*XB*YB)/(Y2-XNBRC*YB*YB)
      PRINT,'LINE SOURCE'
      PRINT,'X,Y,SLOPE',XB,YB,ALPH,ALPH1,DB
      PRINT,'NUMBER OF NO DEPTH',NBZE
      DO 130 IR=1,NBRC
      X(IR)=X(IR)-XB
      Y(IR)=Y(IR)-YB
      XT=XT+X(IR)*X(IR)
      YT=YT+Y(IR)*Y(IR)
      XYT=XYT+X(IR)*Y(IR)
  130 CONTINUE
      ALPH=XYT/XT
      ALPH1=XYT/YT
      PRINT,ALPH,ALPH1
  100 CONTINUE
      RETURN
      END
$DATA
```

$DATA

```
C     ****************************************************************
C     PROGRAM LINE.INTER                            STANFORD UNIVERSITY
C     ****************************************************************
C     THIS PROGRAM COMPUTES THE INTERSECTION OF TWO LINES IN THE SAME
C     PLANE.  IT IS USED TO OBTAIN THE INTERSECTION OF TWO LINE SOURCES
C     AT THE SAME DEPTH.
C     ****************************************************************
C     INPUT FORMAT
C     ************
C
C      COL      VARIABLE NAME     VARIABLE DESCRIPTION
C
C     1.- IDENTIFICATION   1 CARD   (20A4)
C      1-80     HED1                IDENTIFICATION OF THE FIRST LINE
C
C     2.- LINE PARAMTETERS   1 CARD   (3F10.0)
C      1-10     X1                  X COORDINATE OF A POINT OF THE LINE
C     11-20     Y1                  Y COORDINATE OF THE SAME POINT
C     21-30     AL1                 SLOPE OF THE LINE
C
C     3.- IDENTIFICATION    1 CARD   (20A4)
C      1-80     HED2                IDENTIFICATION OF THE SECOND LINE
C
C     2.- LINE PARAMETERS   1 CARD   (3F10.0)
C      1-10     X2                  X COORDINATE OF A POINT OF THE LINE
C     11-20     Y2                  Y COORDINATE OF THE SAME POINT
C     21-30     AL2                 SLOPE OF THE LINE
C
C     OUTPUT
C     ******
C     THE OUTPUT DISPLAYS THE IDENTIFICATION OF THE LINES AND
C     THEIR THE COORDINATES OF THEIR INTERSECTION POINT.
C
C     ****************************************************************
      DIMENSION HED1(20),HED2(20)
C     ****************************************************************
C
  100 READ(5,1000,END=99)HED1
      READ(5,1001)X1,Y1,AL1
      DO 200 I=1,2
      READ(5,1000)HED2
      READ(5,1001)X2,Y2,AL2
 1000 FORMAT(20A4)
 1001 FORMAT(8F10.0)
C
      X=(AL1*X1-AL2*X2-Y1+Y2)/(AL1-AL2)
      IF(Y2.EQ.0.) X=X2
      Y=AL1*(X-X1)+Y1
C
      WRITE(6,2000)HED1,HED2
 2000 FORMAT(' '20A4)
      PRINT,'LINE1',X1,Y1,AL1
      PRINT,'LINE2',X2,Y2,AL2
      PRINT,'INTERSECTION',X,Y
C
  200 CONTINUE
      GO TO 100
   99 RETURN
      END
```

```
C      ******************************************************************
C      PROGRAM LINE.LENGTH                                 STANFORD UNIVERSITY
C      ******************************************************************
C      THIS PROGRAM COMPUTES THE LENGTH OF A SEGMENT OF LINE BETWEEN
C      TWO HORIZONTAL COORDINATES.
C      ******************************************************************
C      INPUT FORMAT
C      ************
C
C       CCL      VARIABLE NAME     VARIABLE DESCRIPTION
C
C      1.- IDENTIFICATION   1 CARD    (20A4)
C       1-80    HED1                LINE IDENTIFICATION
C
C      2.- LINE PARAMETERS   1 CARD   (5F1C.C)
C       1-10    X1                  X COORDINATE OF A POINT OF THE LINE
C      11-20    Y1                  Y COORDINATE OF THE SAME PCINT
C      21-30    ALPH                SLOPE OF THE LINE
C      31-40    XS                  X COORD OF ORIGIN OF SEGMENT
C      41-50    YX                  X COORD OF END OF SEGMENT
C
C      OUTPUT
C      ******
C      THE OUTPUT DISPLAYS THE LINE IDENTIFICATION AND PARAMENTERS AS
C      AS WELL AS THE LENGTH OF THE SEGMENT.
C
C      ******************************************************************
       DIMENSION HED1(20)
C      ******************************************************************
C
  100 READ(5,1001,END=99)HED1
 1001 FORMAT(20A4)
      READ(5,1000)X1,Y1,ALPH,XS,XE
 1000 FORMAT(8F10.0)
      YS=ALPH*(XS-X1)+Y1
      YE=ALPH*(XE-X1)+Y1
      XLEN=SCRT((XS-XE)*(XS-XE)+(YS-YE)*(YS-YE))
      WRITE(6,2000)HED1
 2000 FCRMAT('0',20A4)
      PRINT,'DATA',X1,Y1,ALPH
      PRINT,'ORIGIN  END  LENTGH  ',XS,YS,XE,YE,XLEN
      GC TO 100
   99 RETURN
      END
$DATA
```

```
C     ******************************************************************
C     REGRESSION ANALYSIS                              STANFORD UNIVERSITY
C     ******************************************************************
C     THIS PROGRAM IS TO BE USED FOR REGRESSION ANALYSIS BETWEEN
C     ONE DEPENDENT VARIABLE AND ONE INDEPENDENT VARIABLE.
C     THE LINEAR SCALE IS USED FOR THE INDEPENDENT VARIABLE (X) AND THE
C     LN SCALE FOR THE DEPENDENT VARIABLE (Y).
C     BOTH VARIABLES ARE INPUT ON THE LINEAR SCALE
C     IF THE DEPENDENT VARIABLE IS NOT DETERMINED, THE PROGRAM WILL
C     COMPUTE IT AS (1-CDF) USING A INCREMENT RMIC OF THE DEPENDENT VARIABLE
C     IT CAN EITHER FIT ONE OR TWO LINES ON THE DATA WITH A BREAKING
C     POINT INPUT AS RMBK
C
C     INPUT FORMAT
C     ************
C
C       COL     VARIABLE     VARIABLE DESCRIPTION
C
C     1.-IDENTIFICATION CARD   1 CARD   (5F10.0,2I5,5A4)
C
C      1-10     RMMN         MINIMUM RM VALUE
C     11-20     RMIC         RM INCREMENT TO BE USED TO COMPUTE CDF
C     21-30     RMBK         BREAK OFF MAGNITUDE
C                            IF (RMBK.EQ.0.) ONLY ONE LINE WILL BE FIT
C     31-40     A            AREA
C     41-50     T            TIME
C                            A AND T ARE USED TO NORMALIZE ALPHA
C     51-55     SKIPCD       = 1  BOTH X AND Y ARE INPUT
C                                 RMMN,RMIC ARE INPUT AS ZEROS
C                            = 0  ONLY X IS INPUT (AS RM), Y IS COMPUTED FROM CDF
C                                 RMMN,RMIC ARE TO BE INPUT
C     56-60     SKIPDZ       = 0  INTERVALS WITH NO EVENT WILL NOT BE
C                                 CONSIDERED IN REGRESSION ANALYSIS
C                            = 1  ALL INTERVALS WILL BE CONSIDERED
C     61-80     HED          TITLE
C
C     2.- X AND Y INPUT CARDS  NBRC CARDS   (2F10.0)
C                            INPUT IF SKIPCD=1
C
C
C      1-10     X            INDEPENDENT VARIABLE
C     11-20     Y            DEPENDENT VARIABLE
C
C     3.- RM INPUT CARDS         NBRC CARDS   (50X,F3.1)
C                            SET 1002 FORMAT AS A FUNCTION OF DATA
C                            INPUT IF SKIPCD=0
C
C      1-10     RM           INDEPENDENT VARIABLE
C
C     4.-END OF FILE CARD (ONLY IF RM IS INPUT)   ONE CARD  (50X,F3.1)
C
C     51-53     RM           VALUE GREATER THAN 9.
C
C     NOTE
C
C     IF RM IS INPUT, SEVERAL FILES CAN BE RUN AT ONE TIME BY REPEATING
C     THE INPUT SEQUENCE DESCRIBED ABOVE.
C
C     OUTPUT
C     ******
C     THE OUTPUT DISPLAYS THE INPUT, THE INTERVAL FREQUENCY,THE
C     FREQUENCY OF OCCURRECNCE ABOVE A GIVEN MAGNITUDE, THE REGRESSION
C     COEFFICIENTS ALPHA AND BETA AND ALPHA NORMALIZED WITH RESPECT
C     TO TIME AND AREA OR LENGTH.
C
C     ******************************************************************
      DIMENSION RM(2500),X(50),Y(50),YY(50),IHIS(50),HED(5),
     1 ALPHA(2),BETA(2)
      INTEGER SKIPCD,SKIPDZ
C     ******************************************************************
C
  111 READ(5,1000,END=99)RMMN,RMIC,RMBK,A,T,SKIPCD,SKIPDZ,HED
 1000 FORMAT(5F10.0,2I5,5A4)
      WRITE(6,2000)HED
 2000 FORMAT('1REGRESSION ANALYSIS'/'OLINEAR-LN SCALE'/'0'7A4//)
      IF(SKIPCD.EQ.0) GO TO 200
C
      NBIC=1
C
  100 READ(5,1001,END=104)X(NBIC),YY(NBIC)
      NBIC=NBIC+1
      GO TO 100
C
  104 NBIC=NBIC-1
 1001 FORMAT(2F10.0)
      WRITE(6,2002)NBIC
 2002 FORMAT('0NUMBER OF RECORDS'I5/'0INPUT VARIABLES'/
     *'0INDEPENDENT  DEPENDENT')
      DO 150 IX=1,NBIC
  150 WRITE(6,2011)X(IX),YY(IX)
 2011 FORMAT(' '2F11.2)
      GO TO 201
  200 CONTINUE
C
C     COMPUTE HISTOGRAM
C      CAUTION  FORMAT SET TO READ DATA FROM TAPE U599
C
      NBRC=0
      RMLW=10.
C
  112 NBRC=NBRC+1
  109 READ(5,1002)RM(NBRC)
 1002 FORMAT(74X,F3.2)
      RM(NBRC)=FLOAT(IFIX(RM(NBRC)*10.+.501))/10.
      IF(RM(NBRC).GE.9.) GO TO 105
      IF(RM(NBRC).LT.RMMN) GO TO 110
      IF(RM(NBRC).LT.RMLW) RMLW=RM(NBRC)
      GO TO 112
  110 WRITE(6,2009) NBRC,RM(NBRC)
 2009 FORMAT(' RECORD',I5,'  HAS MAGNITUDE',F10.2,'  IT IS DISREGARDED')
      GO TO 109
C
C
  105 NBRC=NBRC-1
      RMCK1=RMMN
      WRITE(6,2001)NBRC,A,T
 2001 FORMAT('0NUMBER OF RECORDS  ',I5/'0AREA',10X,F10.2,/
     *'0TIME (YEARS) ',F11.2)
      IF(NBRC.LT.2) GO TO 111
```

```
      WRITE(6,2112)RMMN,RMIC
 2112 FORMAT('OMINIMUM MAGNITUDE',12X,F10.2 /
     *'OMAGNITUDE INCREMENT FOR CDF   ',F10.2)
      DO 120 I=1,50
      RMCK=RMCK1+RMIC
      IF(RMLW.LT.(RMCK-.05)) GO TO 121
      RMCK1=RMCK
  120 WRITE(6,2220) RMMN,RMCK
 2220 FORMAT(' THERE IS NO RECORD BETWEEN MAGNITUDE',F8.2,' AND',F8.2)
C
  121 CONTINUE
      WRITE(6,2004)
 2004 FORMAT('OEARTHQUAKE MAGNITUDES')
      WRITE(6,2003)(RM(IX),IX=1,NBRC)
 2003 FORMAT(' '13F10.2)
      RMIC2=RMIC*.5
      X(1)=RMCK1+RMIC2
      NBIC=0
      DO 102 I=1,49
      X(I+1)=X(I)+RMIC
  102 IHIS(I)=0
C
      RMMN1=RMCK1-.1
      DO 103 IX=1,NBRC
      NBKC=((RM(IX)-RMMN1)/RMIC)+.999
      IHIS(NBKC)=IHIS(NBKC)+1
      IF(NBKC.GT.NBIC) NBIC=NBKC
  103 CONTINUE
C
      IF(SKIPDZ.EQ.1.OR.SKIPCD.EQ.1) GO TO 133
C
      I=0
C
  131 I=I+1
  134 IF(I.GE.NBIC) GO TO 133
      IF(IHIS(I).NE.0) GO TO 131
      NBIC1=NBIC-1
      DO 132 K=I,NBIC1
      X(K)=X(K+1)
  132 IHIS(K)=IHIS(K+1)
      NBIC=NBIC-1
      GO TO 134
C
  133 CONTINUE
      IF(NBIC.LT.2) GO TO 111
C     COMPUTE CDF
      YY(NBIC)=IHIS(NBIC)
      NBIC1=NBIC+1
      DO 130 IX=2,NBIC
      KX=NBIC1-IX
  130 YY(KX)=YY(KX+1)+FLOAT(IHIS(KX))
      WRITE(6,2005)
 2005 FORMAT('0',7X,'RM',10X,'INTERVAL',10X,'CUMULATIVE FREQUENCY' /
     *'        INTERVAL',5X,'FREQUENCY',10X,'OCCURRENCES ABOVE RM' /)
      DO 160 IX=1,NBIC
      RM1=X(IX)-RMIC2
      RM2=X(IX)+RMIC2-.01
  160 WRITE(6,2006)RM1,RM2,IHIS(IX),YY(IX),RM1
 2006 FORMAT(' 'F7.2,' - ',F4.2,I8,12X,F10.0,8X,F6.2)
C
```

```
  201 DO 202 IX=1,NBIC
  202 Y(IX)=ALOG(YY(IX))
C     CHECK WHETHER THERE WILL BE ONE OR TWO REGRESSION LINES
C
      IR=1
      NBPT=NBIC
      IF(RMBK.EQ.0.) GO TO 300
C
      NBPT=0.
      DO 320 IX=1,NBIC
      IF(X(IX).GT.RMBK) GO TO 340
  320 NBPT=NBPT+1
C
  340 NBPT1=NBIC-NBPT+1
      WRITE(6,2110)RMBK,NBPT,NBPT1
 2110 FORMAT('OTWO STRAIGHT LINES WILL BE USED TO FIT THE DATA'/
     1 ' BREAK POINT MAGNITUDE',F8.2,/' ',I5,' POINTS IN THE FIRST LINE'
     2 /' ',I5,' POINTS IN THE SECOND LINE' )
      GO TO 300
C
  330 NBPT1=NBPT-1
      NBPT=NBIC-NBPT1
      RMBK=0.
      IR=IR+1
      DO 350 IX=1,NBPT
      X(IX)=X(IX+NBPT1)
  350 Y(IX)=Y(IX+NBPT1)
C
  300 WRITE(6,2130)IR
 2130 FORMAT('OINTERCEPT AND SLOPE OF LINE',I5)
C
C     COMPUTE ALPHA  INTERSEPT
C     COMPUTE BETA  SLOPE
C
C     COMPUTE MEAN
      SMXX=0.
      SMXY=0.
      SMX=0.
      SMY=0.
      PRINT,'NBPT',NBPT
      WRITE(6,3333)(Y(I),I=1,NBPT)
      WRITE(6,3333)(X(I),I=1,NBPT)
 3333 FORMAT(' '13F10.5)
      DO 140 IX=1,NBPT
      SMXX=SMXX+X(IX)*X(IX)
      SMX=SMX+X(IX)
      SMXY=SMXY+X(IX)*Y(IX)
  140 SMY=SMY+Y(IX)
      XNBPT=NBPT
      YM=SMY/XNBPT
      XM=SMX/XNBPT
      BETA(IR)=(SMXY-XNBPT*YM*XM)/(SMXX-XNBPT*XM*XM)
      ALPHA(IR)=YM-BETA(IR)*XM
      WRITE(6,2007)ALPHA(IR),BETA(IR)
 2007 FORMAT('OALPHA',F10.6/'OBETA ',F10.6)
C
      IF(A.EQ.0..OR.T.EQ.0.) GO TO 360
      ALPHAN=ALPHA(IR)-ALOG(A*T)
      WRITE(6,2008)ALPHAN
 2008 FORMAT('ONORMALIZED ALPHA',F10.6 //)
```

```
  360 CONTINUF
C
      IF(RMBK.NE.0.) GO TO 330
      IF(IR.EQ.1) GO TO 111
C
C     COMPUTE INTERSECTION POINT IF THERE ARE TWO LINES
      XM=ABS((ALPHA(1)-ALPHA(2))/(BETA(1)-BETA(2)))
      XLN=ALPHA(1)+BETA(1)*XM
      WRITE(6,2120)XM,XLN
 2120 FORMAT('0INTERSECTION POINT'/' MAGNITUDE',F8.2,/' LN OF N   ',F8.2)
C
      GO TO 111
   99 RETURN
      END
$DATA
```

```
C     ****************************************************************
C     PROGRAM ACC.LINE.AREA                          STANFORD UNIVERSITY
C     ****************************************************************
C     THIS PROGRAM COMPUTES PROBABILITY OF EXCEEDANCE OF GIVEN PEAK
C     GROUND ACCELERATIONS AT SPECIFIED SITES DUE TO LINE OR AREA
C     SEISMIC SOURCES.
C     ****************************************************************
C     INPUT FORMAT
C     ************
C
C     1.- IDENTIFICATION CARD              1 CARD    20A4
C
C      1-80    HED1        TITLE
C
C     2.- ATTENUATION CONSTANTS            1 CARD    3F10.0
C
C      1-10    B1
C     11-20    B2
C     21-30    B3
C     31-40    B4
C     41-50    DELTAL      STEP SIZE FOR LINE INTEGRATION
C     51-60    DELTAC      STEP SIZE FOR CIRCLE INTEGRATION
C                          UNITS OF LENGTH USED IN THE PROGRAM
C              ATTENUATION FORMULA OF THE TYPE
C              ACC=B1*EXP(B2*MAG)/(R+B4)**B3
C
C     3.- PROBLEM DESCRIPTION              4 CARDS
C
C     CARD 1   4I5
C      1- 5    NL          NUMBER OF LINE SOURCES
C      6-10    NA          NUMBER OF AREA SOURCES
C     11-15    NT          NUMBER OF TIME PERIODS
C     16-20    NY          NUMBER OF ACC
C
C     CARD 2   TIME PERIODS, NT VALUES, 8 VALUES PER CARD     8F10.0
C      1-10    T(1)        PERIOD 1
C     11-20    T(2)        PERIOD 2
C     .....
C              T(NT)       PERIODS NT
C
C     CARD 3   PEAK GROUND ACC., NY VALUES, 8 VALUES PER CARD   8F10.0
C      1-10    Y(1)        PGA 1
C     11-20    Y(2)        PGA 2
C     .....
C              Y(NY)       PGA NY
C
C     CARD 4   SEARCHING GRID DESCRIPTION   8F10.0
C      1-10    XBEGIN      ORIGIN OF GRID X COORD
C     11-20    YBEGIN      ORIGIN OF GRID Y COORD
C     21-30    XEND        END OF GRID X COORD
C     31-40    YEND        END OF GRID Y COORD
C                          ORIGIN AND END SHOULD COINCIDE IF ONLY
C                          ONE LOCATION IS REQUIRED
C     41-50    DX          X INCREMENT
C     51-60    DY          Y INCREMENT
C                          DX AND DY MUST BE DIFFERENT FROM ZERO
C
C     4.- LINE SOURCES PROPERTIES    3 CARDS PER SOURCE
C
```

```
C     CARD 1
C      1-80    HED2        IDENTIFICATION OF THE LINE SOURCE
C
C     CARD 2   7F10.0
C              PROPERTIES ON THE LEFT OF BREAKING POINT
C      1-10    ALPHA1( )   NORMALIZED INTERCEPT
C     11-20    BETA1( )    SLOPE
C     21-30    XL1( )      X COORD FOR ORIGIN
C     31-40    XL2( )      X COORD OF END
C     41-50    YL1( )      Y COORD OF ORIGIN
C     51-60    YL2( )      Y COORD OF END
C     61-70    HL( )       DEPTH OF LINE
C
C     CARD 3     3F10.0
C              PROPERTIES ON THE RIGHT OF BREAKING POINT
C              INPUT THE SAME VALUES FOR ALPHA AND BETA
C              AND DUMMY BREAKING POINT IF THERE IS NO BREAKING POINT
C      1-10    ALPHA2( )   NORMALIZED INTERCEPT
C     11-20    BETA2( )    SLOPE
C     21-30    RML( )      BREAKING POINT MAGNITUDE
C
C     5.- AREA SOURCES PROPERTIES     3 CARDS PER SOURCE
C
C     CARD 1   20A4
C      1-80    HED         AREA SOURCE IDENTIFICATION
C
C     CARD 2   6F10.0
C              PROPERTIES ON THE LEFT OF BREAKING POINT
C      1-10    ALPHA1( )   NORMALIZED INTERCEPT
C     11-20    BETA1( )    SLOPE
C     21-30    XL1( )      X COORD OF CIRCLE CENTER
C     31-40    YL1( )      Y COORD OF CIRCLE CENTER
C     41-50    XL2( )      RADIUS OF CIRCLE
C     51-60    HL( )       DEPTH OF AREA SOURCE
C
C     CARD 3   3F10.0
C              PROPERTIES ON THE RIGHT OF BREAKING POINT
C              INPUT SAME VALUES FOR ALPHA AND BETA AND
C              DUMMY BREAKING POINT IF THERE IS NO BREAKING POINT
C      1-10    ALPHA2( )   NORMALIZED INTERCEPT
C     11-20    BETA2( )    SLOPE
C     21-30    RML( )      BREAKING POINT MAGNITUDE
C
C     OUTPUT
C     ******
C     DEPENDING UPON THE INPUT, THE OUTPUT WILL DISPLAY FROM ONE
C     PROBABILITY OF EXCEEDANCE AT ONE POINT TO A WHOLE CDF FOR A
C     WHOLE GRID OF POINTS
C
C     ****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION HED1(20),HED2(20)
      COMMON/SOURCE/ALPHA1(20),ALPHA2(20),BETA1(20),BETA2(20),RML(20),
     1              HL(20)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC
      DIMENSION XL1(20),YL1(20),XL2(20),YL2(20),T(10),YG(30),PDF(30),
     1  FY1(30),FY2(30)
C     ****************************************************************
C
C               READ AND WRITE  ATTENUATION CONSTANTS
```

```
C
      READ(5,1040)HED1
 1040 FORMAT(20A4)
      WRITE(6,1041)HED1
 1041 FORMAT('0',20A4 )
      READ(5,1000)B1,B2,B3,B4,DELTAL,DELTAC
      WRITE(6,1020)B1,B2,B3,B4,DELTAL,DELTAC
 1020 FORMAT('0','ATTENUATION CONSTANTS',//,' B1=',E15.7,3X,'B2=',E15.7,
     &3X,'B3=',E15.7,3X,'B4=',E15.7 /' DELTAL =',E15.7,3X,'DELTAC ='
     1  E15.7 /)
 1000 FORMAT(8F10.0)
C
C     READ AND WRITE GEOMETRIC CONSTANTS
      READ(5,1001)NL,NA,NT,NY
 1001 FORMAT(10I5)
      READ(5,1000)(T(I),I=1,NT)
      WRITE(6,2210)
      WRITE(6,2220)(T(I),I=1,NT)
      NY=NY+1
      READ(5,1000) (YG(I),I=2,NY)
      WRITE(6,2230)
      WRITE(6,2220)(YG(I),I=2,NY)
 2220 FORMAT(' ',10F10.2)
 2210 FORMAT('OTIME PERIODS')
 2230 FORMAT('OACCELERATIONS')
      YG(1)=0.0D0
 2222 FORMAT('0','SITE LOCATION',/,' ','X= ',F10.3,5X,'Y= ',F10.3)
  350 READ(5,1000) XBEGIN,YBEGIN,XEND,YEND,DX,DY
      NXMAX=DABS((XBEGIN-XEND)/DX)+1.9D0
      NYMAX=DABS((YBEGIN-YEND)/DY)+1.9D0
      WRITE(6,1021)NL,NA,NXMAX,NYMAX,NT
 1021 FORMAT('0','GEOMETRIC CONSTANTS',//,' NL=',I5,5X,'NA = ',I5,5X,
     &'NXMAX= ',I5,5X,'NYMAX=',I5,5X,'NT=',I5 / )
      IF(NL.LE.0) GO TO 610
C
C               READ AND WRITE LINE SOURCE PROPERTIES
C
      WRITE(6,1024)
 1024 FORMAT('OLINE SOURCES'/' *************' / )
      DO 616 I=1,NL
      READ(5,1040)HED2
      READ(5,1000)ALPHA1(I),BETA1(I),XL1(I),XL2(I),YL1(I),
     &YL2(I),HL(I)
      READ(5,1000) ALPHA2(I),BETA2(I),RML(I)
      WRITE(6,1041)HED2
      WRITE(6,1022)
      WRITE(6,1023)ALPHA1(I),BETA1(I),XL1(I),XL2(I),YL1(I),YL2(I),HL(I)
 1022 FORMAT(' ',2X,'ALPHA1',10X,'BETA1',11
     &X,'XL1',11X,'XL2',11X,'YL1',11X,'YL2',12X,'HL')
 1023 FORMAT(' ',E13.5,6E14.5)
      WRITE(6,1031)
      WRITE(6,1023) ALPHA2(I),BETA2(I),RML(I)
 1031 FORMAT(' SECOND REGRESSION CONSTANTS',/' ',2X,'ALPHAL2',9X,
     &'L2',10X,'MR')
  616 CONTINUE
      DO 700 IL=1,NL
      IF(XL1(IL).LT.XL2(IL)) GO TO 700
      XD=XL1(IL)
      YD=YL1(IL)
      XL1(IL)=XL2(IL)
      YL1(IL)=YL2(IL)
      XL2(IL)=XD
      YL2(IL)=YD
  700 CONTINUE
  610 IF(NA.LE.0) GO TO 551
C
C           READ AND WRITE AREA SOURCE PROPERTIES
      I1=NL+1
      NN=NL+NA
      WRITE(6,2124)
 2124 FORMAT(' '//' AREA SOURCES'/' *************' / )
C
      DO 615 I=I1,NN
      READ(5,1040)HED2
      READ(5,1000) ALPHA1(I),BETA1(I),XL1(I),YL1(I),XL2(I),HL(I)
      READ(5,1000) ALPHA2(I),BETA2(I),RML(I)
      WRITE(6,1041)HED2
      WRITE(6,2120)
      WRITE(6,1023) ALPHA1(I),BETA1(I),XL1(I),YL1(I),XL2(I),HL(I)
      WRITE(6,2123)
      WRITE(6,1023) ALPHA2(I),BETA2(I),RML(I)
  615 CONTINUE
C
 2120 FORMAT(' ',2X,'ALPHA1',10X,'BETA1',11X,'XO'
     &,12X,'YO',12X,'R',13X,'HA')
 2123 FORMAT(' SECOND REGRESSION CONSTANTS',/,' ',2X,'ALPHA2',10X,
     &'BETA2',10X,'MR')
  551 CONTINUE
C
C     ITERATION ON TIME PERIODS
  650 DO 370 IT=1,NT
      WRITE(6,225)
      WRITE(6,3000) T(IT)
C     WRITE(10,5020) T(IT)
 5020 FORMAT('TIME PERIOD',3X,F6.2)
 3000 FORMAT('0',' TIME PERIOD=',F10.2,' YRS',//)
C
C     ITERATION ON GRID
C     ITERATION IN THE Y DIRECTION
      Y=YBEGIN
      DO 385 IY=1,NYMAX
C
C     ITERATION IN THE X DIRECTION
      X=XBEGIN
      DO 380 IX=1,NXMAX
      WRITE(6,2222) X,Y
      PDF(1)=0.0D0
C
C     ITERATION ON PGA
      DO 360 II=2,NY
      YGII=YG(II)
      YGIIB1=YGII/B1
      SUM = 0.0D0
      SUM1=0.0D0
C
C     ITERATION ON LINE SOURCES
      IF(NL.EQ.0) GO TO 441
      DO 351 IL=1,NL
C
      CALL CONSTL(X,Y,XL1(IL),YL1(IL),XL2(IL),YL2(IL),
```

```
     1                AL1,AL2,DLIL,AIL,BIL)
      HLIL=HL(IL)
      GAM22=DEXP(ALPHA2(IL))
      DEL22=BETA2(IL)/B2
      RHO22=DEL22*B3
      FFY=(DLIL*DLIL)+(HLIL*HLIL)
      RH=(DSQRT(FFY)+B4)**RHO22
      EXCK=RH*GAM22*(YGIIB1**DEL22)*(AL2+AL1)*T(IT)
      IF(EXCK.LE.1.D-5) GO TO 351
      CALL  INTGLN(IL,XL1(IL),YL1(IL),XL2(IL),YL2(IL),AL1,AL2,DLIL,
     1  HL(IL),AIL,BIL,YGII,X,Y,FFY,GAM22,DEL22,RHO22,FF,FF1)
      SUM=SUM + FF
      SUM1=SUM1+FF1
  351 CONTINUE
C
C                AREA SOURCE COMPUTATION
C
  441 IF(NA.EQ.0) GO TO 442
      II=NL+I
      IEND=NL+NA
      DO 850 IA=I1,IEND
C
C     CHECK WHETHER THE CIRCLE CONTRIBUTES ANY TO THE PROB
      RIA=XL2(IA)
      HLIL=HL(IA)
      GAM22=DEXP(ALPHA2(IA))
      DEL22=BETA2(IA)/B2
      RHO22=DEL22*B3
      DIST=DSQRT((X-XL1(IA))*(X-XL1(IA))+(Y-YL1(IA))*(Y-YL1(IA)))
      RH=(DIST+B4)**RHO22
      EXCK=RH*GAM22*(YGIIB1**DEL22)*(6.2831D0*RIA*RIA)*T(IT)
      IF(EXCK.LE.1.D-5) GO TO 850
      SUMP=0.D0
      SUMP1=0.D0
      NR=RIA/DELTAC+0.9D0
      DR=RIA/NR
      DR1=DR*.5D0
C
C       ITERATION ON THE NB OF SEGMENTS IN THE CIRCLE
      DO 202 IR=1,NR
      DL1=DABS(DIST-DR1)
      DL2=DIST+DR1
      AL=DSQRT(RIA*RIA-DR1*DR1)
      FFY=DL1*DL1+HLIL*HLIL
      CALL  INTGLN(IA,0.D0,DL1,AL,DL1,0.D0,AL,DL1,HLIL,0.D0,DL1,
     1  YGII,0.D0,0.D0,FFY,GAM22,DEL22,RHO22,FF,FF1)
      SUMP=SUMP+FF*2.D0
      SUMP1=SUMP1+FF1*2.D0 •
      FFY=DL2*DL2+HLIL*HLIL
      CALL  INTGLN(IA,0.D0,DL2,AL,DL2,0.D0,AL,DL2,HLIL,0.D0,DL2,
     1  YGII,0.D0,0.D0,FFY,GAM22,DEL22,RHO22,FF,FF1)
      SUMP=SUMP+FF*2.D0
      SUMP1=SUMP1+FF1*2.D0
      DR1=DR1+DR
  202 CONTINUE
C
      SUMP=SUMP*DR
      SUMP1=SUMP1*DR
      SUM=SUM+SUMP
      SUM1=SUM1+SUMP1
  850 CONTINUE
C
  442 CONTINUE
      FY1(II)=DEXP(-SUM*T(IT))
      FY2(II)=1.0D0-FY1(II)
      PDF(II)=-SUM1*T(IT)*FY1(II)
  360 CONTINUE
C
C     WRITE(10,5000)(FY2(J),J=2,NY)
      NYY=(NY-2)/10+1
      K=2
      NY1=11
      DO 375 JJ=1,NYY
      IF(JJ.EQ.NYY) NY1=NY
      WRITE(6,226)(YG(J),J=K,NY1)
      WRITE(6,227)(FY2(J),J=K,NY1)
      WRITE(6,228)(FY1(J),J=K,NY1)
C     WRITE(6,229)(PDF(J),J=K,NY1)
      NY1=NY1+10
      K=K+10
  375 CONTINUE
 5010 FORMAT('SITE  ',2F10.2)
 5000 FORMAT(10F8.5)
  226 FORMAT('0','PGA =  ',10F10.4)
  227 FORMAT(' ','P(Y>YO)',10F10.4)
  228 FORMAT(' ','P(Y<YO)',10F10.4)
  229 FORMAT(' ','PDF(Y) ',10F10.4)
C
C     MOVE TO THE NEXT POINT ALONG THE GRID
  380 X=X+DX
  385 Y=Y+DY
  370 CONTINUE
  365 CONTINUE
  225 FORMAT('1','*********** P R O B A B I L I T Y  D I S T R I B U T
    &I O N  O F  P E A K  G R O U N D  A C C E L E R A T I O N *******
    &****',//)
      STOP
      END
      SUBROUTINE CONSTL(X,Y,XL1,YL1,XL2,YL2,
     1                AL1,AL2,DLIL,AM,B)
C
C     ****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
C     ************* **************************************************
C
C  AM = SLOPE OF LINE DEFINED FY (X1,Y1),(X2,Y2)
C  B =  Y-INTERSEPT
C
      AM=(YL2-YL1)/(XL2-XL1)
      B=YL1-AM*XL1
      XBAR=(X+AM*Y-B*AM)/(AM*AM+1.0D0)
      YBAR=(AM*X+Y*AM*AM+B)/(AM*AM+1.0D0)
      DLIL=DSQRT((X-XBAR)*(X-XBAR)+(Y-YBAR)*(Y-YBAR))
C
C CHECK POSITION OF (XBAR,YBAR) ALONF LINE W.R.T. END
C OF POINTS OF LINE SOURCE
      AL1=DSQRT((XL1-XBAR)*(XL1-XBAR)+(YL1-YBAR)*(YL1-YBAR))
      AL2=DSQRT((XL2-XBAR)*(XL2-XBAR)+(YL2-YBAR)*(YL2-YBAR))
C
      IF(XBAR.LT.XL1) AL1=-AL1
```

```
      IF(XBAR.LE.XL2)  RETURN
      DUM = AL1
      AL1 = -AL2
      AL2 = DUM
      RETURN
      END
      SUBROUTINE INTGLN(IL,XL1,YL1,XL2,YL2,AL1,AL2,DLIL,HLIL,AIL,BIL,
     1  YGII,X,Y,FFY,GAM22,DEL22,RHO22,FF,FF1)
C
C     THIS SUBROUTINE COMPUTES THE INTEGRAL ALONG A LINE
C     IT IS CALLED FOR LINE SOURCES AS WELL AS FOR CIRCLES SOURCES
C     THE PARAMETERS ALPHA AND BETA TO BE USED ARE FIRST CHECKED
C
C     *****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER CASE
      DIMENSION XX(4),YY(4),DEL(2),GAM(2),RHO(2)
      COMMON/SOURCE/ALPHA1(20),ALPHA2(20),BETA1(20),BETA2(20),RML(20),
     1               HL(20)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC
C     *****************************************************************
C
C     DETERMINE LINE PARAMATERS
      GAM11=DEXP(ALPHA1(IL))
      DEL11=BETA1(IL)/B2
      RHO11=DEL11*B3
      NBSG=1
      XX(1)=XL1
      YY(1)=YL1
C
C     COMPUTE EPICENTRAL DISTANCE RECK AT WHICH AN EARTHQUAKE
C     OF BREAKPOINT MAGNITUDE RML(IL) WILL GENERATE AN ACCELERATION
C     YG(II)
C     IF RECK IS IMAGINARY OR SMALLER THAN DLIL, ALPHA2 AND BETA2
C     ARE USED.  OTHERWISE POINTS WHERE ALPHA AND BETA CHANGE VALUE
C     ARE DETERMINED ON THE LINE
      TERM=(B1*DEXP(B2*RML(IL))/YGII)**(1.D0/B3)
      IF((TERM-B4).LE.HLIL) GO TO 830
      TERM=(TERM-B4)*(TERM-B4)-(HLIL*HLIL)
C
C     THE EPICENTRAL DISTANCE IS NOT IMAGINARY
      RECK=DSQRT(TERM)
      IF(RECK.LE.DLIL) GO TO 830
C
C     THE EPICENTRAL DISTANCE IS NOT SMALLER THAN DLIL,  POINTS OF
C     INTERSECTION WITH THE LINE ARE COMPUTED
      TERM1=AIL*(BIL-Y)-X
      TERM2=X*X+BIL*BIL+Y*(Y-2.D0*BIL)-RECK*RECK
      TERM3=AIL*AIL+1.D0
      TERM2=DSQRT(TERM1*TERM1-TERM2*TERM3)
C
C     COORDINATES OF THE POINTS OF INTERSECTION
      XI1=(-TERM1+TERM2)/TERM3
      XI2=(-TERM1-TERM2)/TERM3
      YI1=AIL*XI1+BIL
      YI2=AIL*XI2+BIL
      IF(XI1.LT.XI2) GO TO 150
      STOR=XI1
      XI1=XI2
      XI2=STOR
```

```
      STOR=YI1
      YI1=YI2
      YI2=STOR
  150 CONTINUE
C
C     CHECK WHETHER THE POINTS OF INTERSECTION ARE ON THE SEGMENT
C     CONSIDERED AND DETERMINE THE USE OF ALPHA AND BETA
C
      IF(XL1.LT.XI1) GO TO 800
      IF(XL1.GT.XI2) GO TO 830
      IF(XL2.GT.XI2) GO TO 820
C
      CASE=1
      GO TO 850
C
  800 IF(XL2.LT.XI1) GO TO 830
      IF(XL2.LT.XI2) GO TO 840
C
      CASE=5
      NBSG=3
      XX(2)=XI1
      YY(2)=YI1
      XX(3)=XI2
      YY(3)=YI2
      XX(4)=XL2
      YY(4)=YL2
      GO TO 870
C
  830 CASE=3
  850 XX(2)=XL2
      YY(2)=YL2
      GO TO 870
C
  820 CASE=2
      XI1=XI2
      YI1=YI2
      GO TO 860
C
  840 CASE=4
  860 NBSG=2
      XX(2)=XI1
      YY(2)=YI1
      XX(3)=XL2
      YY(3)=YL2
C
  870 CONTINUE
      I=1
      IF(CASE.GT.2) I=2
      DEL(I)=DEL11
      GAM(I)=GAM11
      RHO(I)=RHO11
      I=I+1
      IF(I.EQ.3) I=1
      DEL(I)=DEL22
      GAM(I)=GAM22
      RHO(I)=RHO22
C
      FF=0.D0
      FF1=0.D0
      AL=-AL1
```

```
C
      DO 900 IXSG=1,NBSG
      TERM=0.D0
      IX=IXSG
      IF(IX.EQ.3) IX=1
C
C     COMPUTF LENGTH OF SEGMENT CONSIDERED AND DETERMINE
C     NUMBER OF INCREMENTS
      XLEN=DSQRT((XX(IXSG)-XX(IXSG+1))*(XX(IXSG)-XX(IXSG+1))+
     1          (YY(IXSG)-YY(IXSG+1))*(YY(IXSG)-YY(IXSG+1)))
      NBIC=(XLEN/DELTAL)+.9D0
      IF(NBIC.EQ.0) NBIC=1
      XXNBIC=NBIC
      DELTA=XLEN/XXNBIC
C
C     START DO LOOP AT 1/2 DELTA
      DELDO=DEL(IX)
      RHODO=RHO(IX)
      AL=AL+.5D0*DELTA
C
      DO 100 IXIC=1,NBIC
      RH=AL*AL+FFY
      TERM=TERM+(DSQRT(RH)+B4)**RHODO
      AL=AL+DELTA
  100 CONTINUE
C
      AL=AL-.5D0*DELTA
      TERM=TERM*GAM(IX)*((YGII/B1)**DELDO)*DELTA
      FF=FF+TERM
      FF1=FF1+TERM*DELDO/YGII
  900 CONTINUE
      RETURN
      END
$DATA
```

```
C     ******************************************************************
C     PROGRAM CONST.PROB                               STANFORD UNIVERSITY
C     ******************************************************************
C
C     GIVEN THE CDF ON ACCELERATION P(A.GT.AO) FOR EACH NODE OF A GRID
C     THIS PROGRAM FINDS THE ACCELERATION (AO) CORRESPONDING TO A GIVEN
C     PROBABILITY USING LINEAR INTERPOLATION.  THE GRID IS COVERED
C     STARTING FROM  BOTTOM LEFT NODE, ITERATIONS ARE MADE FIRST IN
C     THE HORIZONTAL DIRECTION
C
C     ******************************************************************
C     INPUT FORMAT
C     ************
C
C      COL      VARIABLE NAME      VARIABLE DESCRIPTION
C
C     1.- GENERAL INFORMATION  1 CARD  (4I5)
C      1- 5     NBPD               NB OF RUNS REQUIRED
C      6-10     NBAC               NB OF ACC GIVEN FOR EACH NODE
C     11-15     NBXX               NB OF COLUMNS
C     16-20     NBYY               NB OF ROWS
C
C     2.- CDF PARAMETERS   1 CARD   (3F10.0)
C      1-10     ACST               SMALLEST ACC IN CDF
C     11-20     ACIC               ACC INCREMENT IN CDF
C     21-30     PBCK               PROBABILITY AO
C
C     3.- IDENTIFICATION   1 CARD   (20A4)
C      1-80     HED1               RUN IDENTIFICATION
C
C     4.- CDF CARDS   (NBXX*NBYY) CARDS OR SET OF CARDS   (10F8.0)
C      1-10     PB(1)              PROBABILITY OF EXCEEDANCE CORRESPONDING
C                                  TO THE SMALLEST ACCELERATION
C      ...      PB( )
C      ...      PB(NBAC)           PROBABILITY OF EXCEEDANCE CORRESPONDING
C                                  TO THE LARGEST ACCELERATION
C
C     OUTPUT
C     ******
C     THE OUTPUT IS SAVED ON DISK AND CONTAINS THE RUN IDENTIFICATION
C     AND THE ACCELERATION AT EACH NODE CORRESPONDING TO THE GIVEN
C     PROBABILITY OF EXCEEDANCE.  FORMAT (8F10.6)
C
C     ******************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION AC(30),PB(30),ACPB(40),HED1(20),HED2(20)
C     ******************************************************************
C
      READ(5,1010)NBPD,NBAC,NBXX,NBYY
 1010 FORMAT(8I5)
      WRITE(6,2010)NBPD,NBAC,NBXX,NBYY
 2010 FORMAT('0NBPD',I6,'  NBAC',I6,'  NBXX',I6,'  NBYY',I6)
C
      READ(5,1040)ACST,ACIC,PBCK
 1040 FORMAT(8F10.0)
      WRITE(6,2030)ACST,ACIC,PBCK
 2030 FORMAT('0ACST',F10.2,'  ACIC',F10.2,'  PBCK',F10.2)
C
      NBAC1=NBAC+1
      PB(1)=1.D0
      AC(1)=0.D0
      AC(2)=ACST
      DO 120 I=2,NBAC
  120 AC(I+1)=AC(I)+ACIC
C
      PRINT,'AC',AC
C
      DO 100 IP=1,NBPD
      READ(5,1000)HED1
 1000 FORMAT(20A4)
      WRITE(6,2000)HED1
 2000 FORMAT(' ',20A4)
      WRITE(10,1000)HED1
      DO 100 IY=1,NBYY
      DO 110 IX=1,NBXX
C     READ(5,1020)HED1
C1020 FORMAT(//20A4)
C
      READ(5,1030)(PB(I),I=2,NBAC1)
 1030 FORMAT(10F8.0)
C
      DO 150 KP=2,NBAC1
      IF(PBCK.GE.PB(KP)) GO TO 160
  150 CONTINUE
C
      WRITE(6,2020)HED1
 2020 FORMAT('0*** ATTENTION ***'/' EXCEDANCE IS LARGER THAN THE INPUT'
     1  /' '20A4)
      ACPB(IX)=AC(NBAC1)
      GO TO 110
C
  160 ACPB(IX)=AC(KP-1)+((AC(KP)-AC(KP-1))*(PB(KP-1)-PBCK))/
     1  (PB(KP-1)-PB(KP))
  110 CONTINUE
C
      WRITE(6,2040)(ACPB(I),I=1,NBXX)
 2040 FORMAT(' ',12F10.6)
      WRITE(10,3000)(ACPB(I),I=1,NBXX)
 3000 FORMAT(8F10.6)
  100 CONTINUE
      RETURN
      END
$DATA
```

```
C     ****************************************************************
C     PROGRAM ACC.TO.INT                              STANFORD UNIVERSITY
C     ****************************************************************
C     THIS PROGRAM FINDS THE MODIFIED MERCALLI INTENSITIES CORRESPONDING
C     TO A CDF ON ACCELERATION USING THE GUTHENBERG-RICHTER RELATIONSHIP
C     A MONTE-CARLO PROCESS IS USED.  CDF P(A.GT.AO) IS INPUT.
C     ****************************************************************
C     INPUT FORMAT
C     ************
C      COL      VARIABLE NAME     VARIABLE DESCRIPTION
C
C     1.- GENERAL    1 CARD    (3I5)
C      1- 5     NB                 (NUMBER OF POINTS IN CDF AS READ IN)*2
C      6-10     IY                 RANDOM GENERATOR INIATOR
C     11-15     NBPT               NB OF CDF TO BE READ IN
C
C     2.- ACCELERATIONS   8 VALUES PER CARD    (8F10.0)
C      1-10     X(4)               SMALLEST ACC IN CDF
C      ...      X( )
C      ...      X(NB+2)            LARGEST ACC IN CDF
C      ...      X(NB+4)            AN ACC EQUAL OR LARGER THAN X(NB+2).
C                                  MAXIMUM POSSIBLE ACC TO BE USED IN CASE
C                                  INPUT CDF DOES NOT GO UP TO 100%
C
C     THE REMAINING DATA IS READ FROM DISK
C     3.- NODE IDENTIFICATION   1 CARD IMAGE   (20A4)
C      1 80     HED1               IDENTIFICATION
C
C     4.- CDF P(A.GT.AO)   8 VALUES PER CARD IMAGE   (8F10.0)
C      1-10     X(3)               P(A.GT.X(4))
       ...      X( )
       ...      X(NB+1)            P(A.GT.X(NB+2))
C
C     OUTPUT
C     ******
C     THE OUTPUT DISPLAYS THE INPUT, THE NUMBER OF OCCURRENCES OF
C     THE MODIFIED MERCALLI INTESITY IN THE SIMULATION AND THE
C     CORRESPONDING PERCENTAGE.
C
C     ****************************************************************
      DIMENSION X1(44),INTEN(15),HED1(20)
      COMMON/POI/IY,DELPOI
C     ****************************************************************
C
      READ(5,1000)NB,IY,NBPT
      NB2=NB+4
      NB1=NB+1
      X1(1)=0.
      X1(2)=0.
 1000 FORMAT(3I5)
      READ(5,1100)(X1(I),I=4,NB2,2)
 1100 FORMAT(8F10.0)
      X1(NB+3)=100.
      CALL RANDK(IY,YFL,0)
C     YFL=-.01
C
C     READ(10,1020)HED1
C     WRITE(6,2010) HED1
      DO 400 IP=1,NBPT
```

```
      READ(10,1020)HED1
 1020 FORMAT(20A4)
      READ(10,1200)(X1(I),I=3,NB1,2)
 1200 FORMAT(10F8.0)
      DO 60 I=3,NB1,2
   60 X1(I)=1.-X1(I)
      DO 220 I=1,NB1,2
  220 X1(I)=X1(I)*100.
C
      WRITE(6,2010)HED1
 2010 FORMAT(' ',//' ',20A4)
      WRITE(6,2050)
 2050 FORMAT('0',7X,'CDF',7X,'ACC')
C
      WRITE(6,2020)X1
 2020 FORMAT(' ',2F10.3)
      DO 90 IT=1,12
   90 INTEN(IT)=0
C
      DO 100 IT=1,1000
      CALL CDF(X1,NB2,1,ACC)
      INT=3.*(ALOG10(ACC*1000.)+.5)+.5
      IF(INT.LT.1) GO TO 100
C     PRINT,'ACC,INT',ACC,INT
      INTEN(INT)=INTEN(INT)+1
  100 CONTINUE
C
      TOT=0.
      DO 110 INT=1,12
C     PRINT,'INT,NB OF OCC',INT,INTEN(INT)
  110 TOT=TOT+FLOAT(INTEN(INT))
C
      WRITE(6,2060)
 2060 FORMAT('0INTENSITY   PERCENTAGE'/' *********************'/)
      DO 120 INT=1,12
      SUB=FLOAT(INTEN(INT))/TOT
  120 WRITE(6,2030)INT,SUB
  400 CONTINUE
 2030 FORMAT(' ',I9,F13.3)
      RETURN
      END
      SUBROUTINE CDF(X1,KEND,ICK,ANS)
C
C     THIS SUBROUTINE FINDS THE VALUE CORRESPONDING TO THE RANDON
C     VARIABLE ON THE CDF, LINEAR FITTING IS APPLIED IF INDEX.EQ.1
C
C     ****************************************************************
      COMMON/POI/IY,DELPOI
      DIMENSION X1(KEND)
C     ****************************************************************
C
      KEN=KEND/2
      CALL RANDK(IY,YFL,0)
C     YFL=YFL+.01
C
      DO 100 I=1,KEN
      IF(YFL.LT.(X1(2*I-1)/100.)) GO TO 110
  100 CONTINUE
      WRITE(6,1000)
 1000 FORMAT(27H0** ERROR IN CDF INPUT **   //
```

```
     1 36H LAST PERCENTAGE INPUT IS NOT 100.01  //)
      I=I-1
  110 IF(ICK-1) 200,300,120
  200 ANS = X1(2*I)
      RETURN
C
C     LINEAR FITTING HALF DISTANCE BETWEEN INPUT POINTS
  120 IF(I.EQ.KEN)GO TO 140
      IF(I.LT.3) GO TO 130
      XT=(X1(2*I)+X1(2*I-2))*.5
      YT=X1(2*I-1)
      XB=(X1(2*I-4)+X1(2*I-2))*.5
      YB=X1(2*I-3)
      GO TO 150
C
  130 XT=(X1(2*I)+X1(2*I-2))*.5
      YT=X1(2*I-1)
      XB=X1(2*I-2)
      YB=0.
      GO TO 150
  140 XT=X1(2*I)
      YT=100.
  160 XB=(X1(2*I-4)+X1(2*I-2))*.5
      YB=X1(2*I-3)
      GO TO 150
C
C     LINEAR FIT TROUGH INPUT POINTS
  300 XT=X1(2*I)
      YT=X1(2*I-1)
      XB=X1(2*I-2)
      YB=X1(2*I-3)
C
C     CHECK FOR VERTICAL INTERPOLATION
  150 ANS=XT
      IF((XT-XB).LT..00001) RETURN
C
      A=(YT-YB)/(XT-XB)
      ANS=(YFL*100.-(YT-A*XT))/A
      RETURN
      END
      SUBROUTINE RANDK (IY,YFL,INDEX)
C
C     THIS SUBROUTINE GENERATES RANDOM NUMBERS
C
      IY=IY*314159269+453806245
    4 IF(IY.GE.0) GO TO 6
    5 IY=IY+2147483647+1
    6 CONTINUE
      IF(INDEX.GT.0) GO TO 8
      YFL=FLOAT(IY)*.4656613E-9
    8 RETURN
      END
$DATA
```

```
C     ******************************************************************
C     PROGRAM PLOT.EPI                                 STANFORD UNIVERSITY
C     ******************************************************************
C     THIS PROGRAM PLOTS THE EARTHQUAKE EPICENTERS ON A GRID (MAP)
C     GIVEN THE LATITUDE AND LONGITUDE.  DIFFERENT SYMBOLS ARE
C     USED FOR THE DIFFERENT MAGNITUDES.
C     THE PLOT WILL BE ROTATED 90 DEGREES COUNTERCLOCWISE IF IT IS TOO
C     HIGH TO FIT ON THE PLOTTER.  IF BOTH DIMENSIONS ARE TOO BIG, AN
C     MESSAGE WILL BE GENERATED AND THE PLOT ABORTED.
C     ******************************************************************
C     INPUT FORMAT
C     ************
C
C      COL      VARIABLE NAME      VARIABLE DESCRIPTION
C
C     1.- IDENTIFICATION CARD   1 CARD   (80A1)
C      1-80     HED                RUN IDENTIFICATION
C
C     2.- PLOT FLAGS   1 CARD   (7I5)
C      1- 5     NBPL               NB OF PLOTS
C      6-10     SKIP3              =0, WILL PLOT      EQ OF MAG 3
C                                  =1, WILL NOT PLOT EQ OF MAG 3
C     11-15     SKIP4                                 EQ OF MAG 4
C     16-20     SKIP5                                 EQ OF MAG 5
C     21-25     SKIP6                                 EQ OF MAG 6
C     26-30     SKIP7                                 EQ OF MAG 7
C     31-35     SKIP8                                 EQ OF MAG 8
C
C     3.- GRID PARAMETERS   1 CARD   (8F10.0)
C                                  THE ORIGIN OF THE GRID IS DEFINED AS
C                                  THE BOTTOM LEFT CORNER; THE END AS THE
C                                  TOP RIGHT.  THE VERTICAL HAS TO POINT
C                                  NORTH FOR THE DATA TO BE READ IN
C                                  CONSISTENTLY.
C      1-10     XMIN1              X COORD OF ORIGIN
C     11-20     YMIN1              Y COORD OF ORIGIN
C     21-30     XMAX1              X COORD OF END
C     31-40     YMAX1              Y COORD OF END
C     41-50     INDGX              LENGTH OF ONE DEGREE IN INCHES FOR
C                                  THE PLOT (X DIRECTION).
C     51-60     INDGY              LENGTH OF ONE DEGREEE IN INCHES FOR
C                                  THE PLOT (Y DIRECTION)
C     61-70     CAL                PLOTTER TO BE USED (10. OR 29.)
C                                  IF ZERO, WILL BE SET TO 10.
C     71-80     DIVR               THE FRAME COORDINATES ARE ROUNDED OFF
C                                  TO THE CLOSEST (DEGREE/DIVR)
C                                  IF INPUT AS 0, WILL BE SET TO 1
C
C     3.- EPICENTER COORDINATES   1 EPICENTER PER CARD IMAGE   (3F10.0)
C                                  INFORMATION READ FROM DISK
C               X( )               X COORDINATE (LONGITUDE) OF EPICENTER
C               Y( )               Y COORDINATE (LATITUDE) OF EPICENTER
C               RM( )              MAGNITUDE
C
C     OUTPUT
C     ******
C     A FILE IS CREATED ON DISK, IT HAS TO BE TRANSFERRED ON TAPE AND
C     PLOTTED ON A 10 OR 29 INCH CALCOMP PLOTTER
C
```

```
C     ******************************************************************
      DIMENSION AMODES(200),END1(2),END2(2),XX4(500),YY4(500),XX5(500)
     &,YY5(500),XX6(300),YY6(300),XX7(100),YY7(100),XX8(100),YY8(100),
     &X(2050),Y(2050),RM(2050),XX(200),YY(200),XX3(500),YY3(500)
      INTEGER SKIP3,SKIP4,SKIP5,SKIP6,SKIP7,SKIP8
      REAL INRAS,INDG,INDGX,INDGY
      LOGICAL*1 HED(70)
C     ******************************************************************
C
      READ(5,1001)HED
 1001 FORMAT(80A1)
      READ(5,1002)NBPL,SKIP3,SKIP4,SKIP5,SKIP6,SKIP7,SKIP8
 1002 FORMAT(10I5)
      READ(5,1000)XMIN1,YMIN1,XMAX1,YMAX1,INDGX,INDGY,CAL,DIVR
      IF(DIVR.EQ.0.) DIVR=1.
 1000 FORMAT(8F10.0)
      INRAS=100.
      IF(CAL.EQ.29.) INRAS=200.
      XRAS=(ABS(XMAX1-XMIN1)*INDGX+1.5)*INRAS
      YRAS=(ABS(YMAX1-YMIN1)*INDGY+1.5)*INRAS
      XMIN1=XMIN1*DIVR
      XMAX1=XMAX1*DIVR
      YMIN1=YMIN1*DIVR
      YMAX1=YMAX1*DIVR
      INDGX=INDGX/DIVR
      INDGY=INDGY/DIVR
C
C     ORIENTATE FRAME
      DELTAX=.75/INDGX
      DELTAY=.75/INDGY
      IF(YRAS.LE.(CAL*INRAS)) GO TO 112
      IF(XRAS.LE.(CAL*INRAS)) GO TO 110
      WRITE(6,2100)
 2100 FORMAT('0THE SCALE IS TOO LARGE FOR THE PLOTTER, REDUCE INDG PER D
     &EGREE')
      STOP
C
C     INTERCHANGE X AND Y SCALES
  110 WRITE(6,2101)
 2101 FORMAT('0THE PLOT WILL BE ROTATED BY 90 DEGREES')
      STOR=XMIN1
      XMIN1=YMAX1
      YMAX1=XMAX1
      XMAX1=YMIN1
      YMIN1=STOR
      STOR=DELTAX
      DELTAX=DELTAY
      DELTAY=STOR
      STOR=XRAS
      XRAS=YRAS+3.5*INRAS
      YRAS=STOR
      GO TO 111
C
  112 XRAS=XRAS+3.5*INRAS
C
  111 CALL MODESG(AMODES,'MORTGAT,BIN 502',15)
C
      DO 500 IP=1,NBPL
      AMODES(45)=1.
      XMAX=XMAX1
```

```
      YMAX=YMAX1
      XMIN=XMIN1
      YMIN=YMIN1
C
      READ(10,1030)NBRC,HED
 1030 FORMAT(I5,70A1)
C
      IF(YRAS.LE.(CAL*INRAS)) GO TO 100
      DO 120 IX=1,NBRC
  120 READ(10,1010)X(IX),Y(IX),RM(IX)
 1010 FORMAT(19X,F5.3,3X,F5.3,42X,F3.2)
      GO TO 130
C
  100 CONTINUE
      DO 140 IX=1,NBRC
  140 READ(10,1010)Y(IX),X(IX),RM(IX)
C
C     CHECK SIGNS
  130 IF(XMAX1.GT.XMIN1) GO TO 150
      XMAX=-XMAX1
      XMIN=-XMIN1
      DO 160 IX=1,NBRC
  160 X(IX)=-X(IX)
C
  150 XFMAX=XMAX+DELTAX*4.25/.75
      XFMIN=XMIN-DELTAX
      IF(YMAX1.GT.YMIN1) GO TO 170
      YMAX=-YMAX1
      YMIN=-YMIN1
      DO 180 IX=1,NBRC
  180 Y(IX)=-Y(IX)
  170 YFMAX=YMAX+DELTAY
      YFMIN=YMIN-DELTAY
  552 WRITE(6,551)(X(IX),Y(IX),RM(IX),IX=1,NBRC)
  551 FORMAT(' ',12F10.3)
C
      AMODES(97)=XRAS
      AMODES(179)=YRAS
      CALL SUBJEG(AMODES,XFMIN,YFMIN,XFMAX,YFMAX)
      CALL OBJECG(AMODES,0.,0.,XRAS,YRAS)
C
      IF(AMODES(12).NE.AMODES(13))WRITE(6,2102)AMODES(12),AM3DES(13)
 2102 FORMAT('OTHE SCALES ARE NOT THE SAME',2F10.6)
      END1(1)=IFIX(YMIN)
      END2(1)=IFIX(XMAX)
      END1(2)=IFIX(YMAX)
      END2(2)=IFIX(XMIN)
C
      DELTA2=1./(8.*INDGX)
      XMUL=4.
      DELTA1=4.*DELTA2
      DELTA3=3.*DELTA2
      SIGN=-1.
C
      I=1
      VAR=END1(2)
      FIX=END2(2)
C
      DO 400 K=1,2
C
```

```
  401 XX(I)=FIX
      YY(I)=VAR
      XX(I+1)=FIX+DELTA2
      YY(I+1)=VAR
      XX(I+2)=FIX
      YY(I+2)=VAR
      INTG=ABS(VAR)
      XC=FIX-DELTA2*XMUL
      YC=VAR
C
      CALL INUMBG(AMODES,XC,YC,3,INTG)
      WRITE(6,550)XC,YC,INTG
      I=I+3
      IF(VAR.EQ.END1(K)) GO TO 402
      VAR=VAR+SIGN
      GO TO 401
C
  402 STOR=VAR
      VAR=FIX
      FIX=STOR
  404 XX(I)=VAR
      YY(I)=FIX
      XX(I+1)=VAR
      YY(I+1)=FIX+DELTA2
      XX(I+2)=VAR
      YY(I+2)=FIX
      INTG=ABS(VAR)
      XC=VAR
      YC=FIX-DELTA3
C
      CALL INUMBG(AMODES,XC,YC,3,INTG)
      WRITE(6,550)XC,YC,INTG
      I=I+3
      IF(VAR.EQ.END2(K)) GO TO 403
      VAR=VAR-SIGN
      GO TO 404
C
  403 SIGN=-SIGN
      STOR=VAR
      VAR=FIX
      FIX=STOR
      DELTA2=-DELTA2
      XMUL=2.
      DELTA3=-DELTA3
C
  400 CONTINUE
C     DO 500 K=1,I
C 500 WRITE(6,550)XX(K),YY(K)
  550 FORMAT(' ',2F10.3,I6)
      I=I-3
      CALL LINESG(AMODES,I,XX,YY)
C
      I3=0
      I4=0
      I5=0
      I6=0
      I7=0
      I8=0
      DO 300 IX=1,NBRC
      IRM=RM(IX)-1.99
```

```
      IF(IRM.LT.1) GO TO 300
      GO TO (230,240,250,260,270,280),IRM
  230 I3=I3+1
      XX3(I3)=X(IX)
      YY3(I3)=Y(IX)
      GO TO 300
  240 I4=I4+1
      XX4(I4)=X(IX)
      YY4(I4)=Y(IX)
      GO TO 300
  250 I5=I5+1
      XX5(I5)=X(IX)
      YY5(I5)=Y(IX)
      GO TO 300
  260 I6=I6+1
      XX6(I6)=X(IX)
      YY6(I6)=Y(IX)
      GO TO 300
  270 I7=I7+1
      XX7(I7)=X(IX)
      YY7(I7)=Y(IX)
      GO TO 300
  280 I8=I8+1
      XX8(I8)=X(IX)
      YY8(I8)=Y(IX)
  300 CONTINUE
      AMODES(40)=8.*INRAS/100.
      AMODES(41)=14.*INPAS/100.
C
      AMODES(45)=.5
      AMODES(84)=12.
      IF(SKIP3.EQ.0.AND.I3.GT.0) CALL POINTG(AMODES,I3,XX3,YY3)
      IF(SKIP3.EQ.0.AND.I3.GT.0) PRINT,'I3 HAS BEEN CALLED'
      IF(SKIP4.EQ.0.AND.I4.GT.0)CALL POINTG(AMODES,I4,XX4,YY4)
      IF(SKIP4.EQ.0.AND.I4.GT.0)PRINT,'I4 HAS BEEN CALLED'
C
      AMODES(84)=15.
      IF(SKIP5.EQ.0.AND.I5.GT.0)CALL POINTG(AMODES,I5,XX5,YY5)
      IF(SKIP5.EQ.0.AND.I5.GT.0)PRINT,'I5 HAS BEEN CALLED'
C
      AMODES(45)=.35
      AMODES(84)=40.
      IF(SKIP6.EQ.0.AND.I6.GT.0)CALL POINTG(AMODES,I6,XX6,YY6)
      IF(SKIP6.EQ.0.AND.I6.GT.0) PRINT,'I6 HAS BEEN CALLED'
C
      AMODES(45)=2.0
      AMODES(84)=12.
      IF(SKIP7.EQ.0.AND.I7.GT.0)CALL POINTG(AMODES,I7,XX7,YY7)
      IF(SKIP7.EQ.0.AND.I7.GT.0) PRINT,'I7 HAS BEEN CALLED'
C
      AMODES(45)=.65
      AMODES(84)=40.
      IF(SKIP8.EQ.0.AND.I8.GT.0)CALL POINTG(AMODES,I8,XX8,YY8)
      IF(SKIP8.EQ.0.AND.I8.GT.0)  PRINT,'I8 HAS BEEN CALLED'
C
      XT=XMAX-.5/INDGX
      AMODES(50)=90.
      AMODES(46)=90.
      YT=YMIN+DELTA1
      AMODES(45)=.5
      XT=XFMAX-3./INDGX
      CALL VECSG(AMODES,XT,YT,16,' .  MAGNITUDE 4+')
C
      XT=XT+DELTA1
      CALL VECSG(AMODES,XT,YT,16,' +  MAGNITUDE 5+')
C
      XT=XT+DELTA1
      AMODES(45)=.35
      CALL VECSG(AMODES,XT,YT,16,' X  MAGNITUDE 6+')
C
      XT=XT+DELTA1
      AMODES(45)=1.0
      CALL VECSG(AMODES,XT,YT,16,' .  MAGNITUDE 7+')
C
      XT=XT+DELTA1
      AMODES(45)=.55
      CALL VECSG(AMODES,XT,YT,16,' X  MAGNITUDE 8+')
C
      XT=XT+DELTA1
      AMODES(45)=1.5
      CALL VECSG(AMODES,XT,YT,48,HED)
      CALL PICTRG(AMODES)
      PRINT,'MAGNITUDE 3'
      IF(I3.NE.0)WRITE(6,555)(XX3(I),YY3(I),I=1,I3)
      PRINT,'MAGNITUDE 4 +'
      IF(I4.NE.0)WRITE(6,555)(XX4(I),YY4(I),I=1,I4)
      PRINT,'MAGNITUDE 5 +'
      IF(I5.NE.0)WRITE(6,555)(XX5(I),YY5(I),I=1,I5)
      PRINT,'MAGNITUDE 6 +'
      IF(I6.NE.0)WRITE(6,555)(XX6(I),YY6(I),I=1,I6)
      PRINT,'MAGNITUDE 7 +'
      IF(I7.NE.0)WRITE(6,555)(XX7(I),YY7(I),I=1,I7)
      PRINT,'MAGNITUDE 8 +'
      IF(I8.NE.0)WRITE(6,555)(XX8(I),YY8(I),I=1,I8)
  500 CONTINUE
  555 FORMAT(' ',12F10.3)
      CALL EXITG(AMODES)
      RETURN
      END
$DATA
```

```
C     ****************************************************************
C     PROGRAM BYS.ACC.DUR                          STANFORD UNIVERSITY
C     ****************************************************************
C     THIS PROGRAM COMPUTES THE PROBABILITY OF EXCEEDANCE OF GIVEN PEAK
C     GROUND.ACCELERATIONS AND STRONG MOTION DURATION AT SPECIFIED
C     SITES DUE TO LINE OR AREA SEISMIC SOURCES.
C     CDF OF PGA IS COMPUTED WITH INCREMENTS OF .02 G
C     CDF OF DURATION IS COMPUTED WITH INCREMENTS OF 2 SEC
C     ****************************************************************
C     INPUT FORMAT
C     ************
C
C     1.- IDENTIFICATION CARD             1 CARD    20A4
C
C      1-80    HED1        TITLE
C
C     2.- ATTENUATION CONSTANTS           1 CARD    3F10.0
C
C      1-10    B1
C     11-20    B2
C     21-30    B3
C     31-40    B4
C     41-50    DELTAL      STEP SIZE FOR LINE INTEGRATION
C     51-60    DELTAC      STEP SIZE FOR CIRCLE INTEGRATION
C                          UNITS OF LENGTH USED IN THE PROGRAM
C              ATTENUATION FORMULA OF THE TYPE
C              ACC=B1*EXP(B2*MAG)/(R+B4)**B3
C     61-70    UPAC        RATIO OF UPPER BOUND TO MEAN OF UNIFORM
C                          DISTRIBUTION PLACED ON PGA ATTENUATION
C                          RELATIONSHIP
C     71-80    UPDR        RATIO OF UPPER BOUND TO MEAN OF UNIFORM
C                          DISTRIBUTION PLACED ON DURATION ATTENUATION
C                          RELATIONSHIP
C
C     3.- PROBLEM DESCRIPTION            3 CARDS
C
C     CARD 1   6I5
C      1- 5    NL          NUMBER OF LINE SOURCES
C      6-10    NA          NUMBER OF AREA SOURCES
C     11-15    NT          NUMBER OF TIME PERIODS
C     16-20    NY          NUMBER OF ACC
C     21-25    NBGD        NUMBER OF GRIDS
C     26-30    SKSAVE      IF 0 WILL SAVE RESULTS ON DEVICE SPECIFIED
C                          BY JCL FOR DEVICES 11,12 ETC. FOR FIRST,
C                          SECOND, ETC. TIME PERIODS.
C                          IF 1 WILL NOT SAVE RESULTS
C
C     CARD 2   TIME PERIODS, NT VALUES, 8 VALUES PER CARD     8F10.0
C      1-10    T(1)        PERIOD 1
C     11-20    T(2)        PERIOD 2
C     .....
C              T(NT)       PERIODS NT
C
C     4.- LINE SOURCES PROPERTIES    AT LEAST 3 CARDS PER SOURCE
C
C     CARD 1
C      1-80    HED2        IDENTIFICATION OF THE LINE SOURCE
C
C     CARD 2   7F10.0,I10
C              GEOMETRIC DESCRIPTION AND PARAMETERS OF POISSON MODEL
C      1-10    XXOR( )     X COORD OF ORIGIN
C     11-20    XXED( )     X COORD OF END
C     21-30    YYOR( )     Y COORD OF ORIGIN
C     31-40    YYED( )     Y COORD OF END
C     41-50    DP( )       DEPTH OF LINE
C     51-60    TMDA( )     TIME DATA BASE
C     61-70    XNBDA( )    NO OF EVENTS RECORDED ABOVE M=4 ON THIS SOURCE
C     71-80    NB          NO OF DIFFERENT MAG GREATER OR EQUAL TO 4.0
C                          ON THIS SOURCE (.25 INCREMENT)
C
      CARD 3   8 VALUES PER CARD  8F10.0
C              PARAMETERS OF BERNOULLI MODEL
C      1-10    XNBEV( )    NO OF EVENTS BERNOULLI TRIAL IS BASED ON
C     11-20    XNBMG(1)    NO OF SUCCESSES FOR M=4.0
C     21-30    XNBMG(2)    NO OF SUCCESSES FOR M=4.25
C     . . . .
C              XNBMG(NB)  NO OF SUCCESSES FOR LARGEST M ON THIS SOURCE
C
C     5.- AREA SOURCES PROPERTIES     AT LEAST 3 CARDS PER SOURCE
C
C     CARD 1   20A4
C      1-80    HED2        AREA SOURCE IDENTIFICATION
C
C     CARD 2   7F10.0,I10
C              GEOMETRIC DESCRIPTION AND PARAMETERS OF POISSON MODEL
C      1-10    XXOR( )     X COORD OF CIRCLE CENTER
C     11-20    XXED( )     Y COORD OF CIRCLE CENTER
C     21-30    YYOR( )     RADIUS OF CIRCLE
C     31-40                LEAVE BLANK
C     41-50    DP( )       DEPTH OF CIRCLE
C     51-60    TMDA( )     TIME DATA BASE
C     61-70    XNBDA( )    NO OF EVENTS RECORDED ABOVE M=4 ON THIS SOURCE
C     71-80    NB          NO OF DIFFERENT MAG GREATER OR EQUAL TO 4.0
C                          ON THIS SOURCE (.25 INCREMENT)
C
      CARD 3   8 VALUES PER CARD  8F10.0
C              PARAMETERS OF BERNOULLI MODEL
C      1-10    XNBEV( )    NO OF EVENTS BERNOULLI TRIAL IS BASED ON
C     11-20    XNBMG(1)    NO OF SUCCESSES FOR M=4.0
C     21-30    XNBMG(2)    NO OF SUCCESSES FOR M=4.25
C     . . . .
C              XNBMG(NB)  NO OF SUCCESSES FOR LARGEST M ON THIS SOURCE
C
C     6.- GRID DESCRIPTION                 2 CARDS PER GRID
C
C     CARD 1   IDENTIFICATION CARD    20A4
C     1-80     HED2        NAME OF GRID
C
C     CARD 2   SEARCHING GRID DESCRIPTION   8F10.0
C      1-10    XBEGIN      ORIGIN OF GRID X COORD
C     11-20    YBEGIN      ORIGIN OF GRID Y COORD
C     21-30    XEND        END OF GRID X COORD
C     31-40    YEND        END OF GRID Y COORD
C                          ORIGIN AND END SHOULD BE DIAGONALLY OPPOSITE
C                          CORNERS
C     41-50    DX          X INCREMENT
C     51-60    DY          Y INCREMENT
C                          IF ONLY ONE LOCATION IS REQUIRED, INPUT THE
C                          SITE COORDINATES AS XBEGIN AND XEND, AND
C                          INPUT XEND,YEND,DX,DY AS ZEROS
C
```

```
C      OUTPUT
C      ******
C      DEPENDING UPON THE INPUT, THE OUTPUT WILL DISPLAY FROM ONE
C      PROBABILITY OF EXCEEDANCE AT ONE POINT TO A WHOLE CDF FOR A
C      WHOLE GRID OF POINTS
C
C      ****************************************************************
C      NOTE: THE PRESENT DIMENSIONS ALLOW FOR 30 SEISMIC SOURCES,
C      AND 5 TIME PERIODS
C      ****************************************************************
       IMPLICIT REAL*8 (A-H,O-Z)
       LOGICAL*1 USE
       DIMENSION HED1(20),HED2(20)
       COMMON/BRNUI/XNBEV(30),XNBTP(30),XNBMG(30,20)
       COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,UPAC,UPDR
       COMMON/GEOM/ XXOR(30),YYOR(30),XXED(30),YYED(30),DP(30),
      1  TMDA(30),XNBDA(30)
       COMMON/ACVR/PBACAV(101),B1EB2M(20),PBOC(1000),PBZROC(30,20)
      1 ,ACPDF(200),DRPDF(100),PBDRAV(51),DR50(20)
       COMMON/ACIN/IXACMN,NBACAV(101,3),NBDRAV(51,3)
       DIMENSION TM(10)    ,ACUT(10),XXMGST(20),DR501(20)
       INTEGER SKSAVE
       DATA DR501/1.5D0,1.5D0,1.5D0,1.5D0,2.0D0,2.0D0,2.0D0,2.5D0,
      1   3.0D0,5.5D0,10.D0,17.D0,
      1  22.D0,24.25D0,26.D0,27.25D0,28.D0,28.5D0,29.D0,29.5D0/
C      *****************************************************************
C
C               READ AND WRITE  ATTENUATION CONSTANTS
C
       DO 97 I=1,20
    97 DR50(I)=DR501(I)
       DO 98 IX=1,20
       XIX=IX
    98 XXMGST(IX)=3.75D0+XIX*.25D0
C
       YGMN=.05D0
       READ(5,1040)HED1
  1040 FORMAT(20A4)
       WRITE(6,1041)HED1
  1041 FORMAT('0',20A4 )
       READ(5,1000)B1,B2,B3,B4,DELTAL,DELTAC,UPAC,UPDR
       IF(UPAC.EQ.0.D0) UPAC=1.5D0
       IF(UPDR.EQ.0.D0) UPDR=1.5D0
       WRITE(6,1020)B1,B2,B3,B4,DELTAL,DELTAC
  1020 FORMAT('0','ATTENUATION CONSTANTS',//,' B1=',E15.7,3X,'B2=',E15.7,
      &3X,'B3=',E15.7,3X,'B4=',E15.7 /' DELTAL =',E15.7,3X,'DELTAC ='
      1  ,E15.7 /)
  1000 FORMAT(8F10.0)
       YGMNCK=YGMN/UPAC
C
C      READ AND WRITE GEOMETRIC CONSTANTS
       READ(5,1001)NBLN,NBAR,NBTM,NBGD,SKSAVE
       WRITE(6,2030)NBLN,NBAR,NBTM,NBGD
  2030 FORMAT(' NUMBER OF LINE SOURCES  ',I5 /
      1        ' NUMBER OF AREA SOURCES  ',I5 /
      2        ' NUMBER OF TIME PERIODS  ',I5 /
      3        ' NUMBER OF GRIDS         ',I5)
       IF(SKSAVE.EQ.0) WRITE(6,2031)
  2031 FORMAT('USAVE OUTPUT ON CARDS',/)
       NBSC=NBLN+NBAR
  1001 FORMAT(10I5)
       READ(5,1000)(TM(I),I=1,NBTM)
       WRITE(6,2210)
       WRITE(6,2220)(TM(I),I=1,NBTM)
  2220 FORMAT(' ',10F10.2)
  2210 FORMAT('OTIME PERIODS')
  2222 FORMAT('0','SITE LOCATION',/,' ','X= ',F10.3,5X,'Y= ',F10.3)
       IF(NBLN.LE.0) GO TO 610
C
C                READ AND WRITE LINE SOURCE PROPERTIES
C
       WRITE(6,1024)
  1024 FORMAT('OLINE SOURCES'/' ************' / )
       DO 616 IX=1,NBLN
       READ(5,1040)HED2
       READ(5,1010)XXOR(IX),XXED(IX),YYOR(IX),YYED(IX),DP(IX),TMDA(IX),
      1 XNBDA(IX),NB
  1010 FORMAT(7F10.0,I10)
       READ(5,1000 )XNBEV(IX),(XNBMG(IX,I),I=1,NB)
       XNBTP(IX)=NB
       WRITE(6,1041)HED2
C
       WRITE(6,1022)
  1022 FORMAT(' ',7X,'XOR',7X,'YOR',7X,'XED',7X,'YED',5X,'DEPTH',
      1 5X,'OCCURRENCE TIME',5X,'TIME BASE',5X,'NB OF OCC')
       WRITE(6,1023)XXOR(IX),YYOR(IX),XXED(IX),YYED(IX),DP(IX),TMDA(IX),
      1 XNBDA(IX)
  1023 FORMAT (' ',5F10.3,25X,2F10.3)
       WRITE(6,1031) XNBTP(IX),XNBEV(IX)
  1031 FORMAT(' NB OF DIFF MAG.    ',F10.2 /
      1        ' TOTAL NB OF MAG.   ',F10.2 /
      2        ' DISTRIBUTION OF MAG.')
       IXED=0
       DO 616 IXST=1,NB,10
       IXED=IXED+10
       IF(NB-IXST.LT.9)IXED=NB
       WRITE(6,1025)(XXMGST(I),I=IXST,IXED)
   616 WRITE(6,1025)(XNBMG(IX,I),I=IXST,IXED)
  1025 FORMAT(' ',10F12.2)
C
       DO 700 IL=1,NBLN
       IF(XXOR(IL).LT.XXED(IL)) GO TO 700
       XD=XXOR(IL)
       YD=YYOR(IL)
       XXOR(IL)=XXED(IL)
       YYOR(IL)=YYED(IL)
       XXED(IL)=XD
       YYED(IL)=YD
   700 CONTINUE
   610 IF(NBAR.LE.0) GO TO 551
C
C            READ AND WRITE AREA SOURCE PROPERTIES
       IX1=NBLN+1
       WRITE(6,2124)
  2124 FORMAT(' '//' AREA SOURCES'/' *************' / )
C
       DO 615 IX=IX1,NBSC
       READ(5,1040)HED2
       READ(5,1010)XXOR(IX),YYOR(IX),XXED(IX),YYED(IX),DP(IX),TMDA(IX),
      1 XNBDA(IX),NB
       READ(5,1000)XNBEV(IX),(XNBMG(IX,I),I=1,NB)
       XNBTP(IX)=NB
```

```
      WRITE(6,1041)HED2
      WRITE(6,2120)
 2120 FORMAT(' ',7X,'XOR',7X,'YOR',4X,'RADIUS',5X,'DEPTH',
     1 5X,'OCCURRENCE TIME',5X,'TIME BASE',5X,'NB OF OCC')
      WRITE(6,1027)XXOR(IX),YYOR(IX),XXED(IX),DP(IX),TMDA(IX),
     1 XNBDA(IX)
 1027 FORMAT (' ',4F10.3,25X,2F10.3)
      WRITE(6,1031)XNBTP(IX),XNBEV(IX)
      IXED=0
      DO 615 IXST=1,NB,10
      IXED=IXED+10
      IF(NB-IXST.LT.9)IXED=NB
      WRITE(6,1025)(XXMGST(I),I=IXST,IXED)
  615 WRITE(6,1025)(XNBMG(IX,I),I=IXST,IXED)
C
  551 CONTINUE
C
C
C     INITIALIZE DISTRIBUTION ON ACCELERATIONS AND OTHER VARIABLES
      CALL INITIA
      DO 123 I=1,30
      DO 123 J=1,20
  123 PBZROC(I,J)=0.D0
C
C
C     COMPUTE DISTRIBUTION ON THE NUMBER OF EVENTS FOR EACH SOURCE
      DO 100 IXSC=1,NBSC
      CALL BERNUI(IXSC,NBLN,TM(1),TMDA(IXSC),XNBDA(IXSC),XNBEV(IXSC))
  100 CONTINUE
C
C      ITERATION ON THE NUMBER OF GRIDS
      DO 365 IXGD=1,NBGD
      WRITE(6,225)
  225 FORMAT('1','*********** P R O B A B I L I T Y   D I S T R I B U T
     &I O N   O F   P E A K   G R O U N D   A C C E L E R A T I O N ********
     &*****',//)
      READ(5,1040)HED2
      WRITE(6,1041)HED2
      READ(5,1000) XBEGIN,YBEGIN,XEND,YEND,DX,DY
      IF(XEND.EQ.0.D0) XEND=XBEGIN
      IF(YEND.EQ.0.D0) YEND=YBEGIN
      IF(DX.EQ.0.D0) DX=1.D0
      IF(DY.EQ.0.D0) DY=1.D0
      NXMAX=DABS((XBEGIN-XEND)/DX)+1.9D0
      NYMAX=DABS((YBEGIN-YEND)/DY)+1.9D0
      WRITE(6,1021)NBLN,NBAR,NXMAX,NYMAX,NBTM
 1021 FORMAT('0','GEOMETRIC CONSTANTS',//,' NL=',I5,5X,'NA = ',I5,5X,
     &'NXMAX= ',I5,5X,'NYMAX=',I5,5X,'NT=',I5 / )
C
      IF(SKSAVE.NE.0) GO TO 651
      DO 650 IT=1,NBTM
      IWRT=10+2*(IT-1)
      IWRT1=IWRT+1
      WRITE(IWRT,1040)HED1
      WRITE(IWRT1,1040)HED1
      WRITE(IWRT,5021)
 5021 FORMAT('ACCELERATION DISTRIBUTION')
      WRITE(IWRT1,5022)
 5022 FORMAT('DURATION DISTRIBUTION')
      WRITE(IWRT1,5020)TM(IT),XBEGIN,XEND,YBEGIN,YEND,DX,DY
      WRITE(IWRT,5020)TM(IT),XBEGIN,XEND,YBEGIN,YEND,DX,DY
```

```
 5020 FORMAT('TIME PERIOD',F6.2,' XB=',F7.3,' XE=',F7.3,' YB=',F7.3,
     &  ' YE=',F7.3,' DX=',F5.2,' DY=',F5.2)
  650 CONTINUE
  651 CONTINUE
C
C     ITERATION ON GRID
C     ITERATION IN THE Y DIRECTION
      Y=YBEGIN
      DO 385 IY=1,NYMAX
C
C     ITERATION IN THE X DIRECTION
      X=XBEGIN
      DO 380 IX=1,NXMAX
      WRITE(6,2222) X,Y
C
C     INITIALIZE ACCELERATION DISTRIBUTION
      ACPDF(1)=0.D0
      DRPDF(1)=0.D0
      DO 390 I=2,200
  390 ACPDF(I)=1.D0
      DO 391 I=2,100
  391 DRPDF(I)=1.D0
C
C
C     ITERATION ON LINE SOURCES
      IF(NBLN.EQ.0) GO TO 441
C
      DO 351 IXSC=1,NBSC
      CALL CONSTL(IXSC,X,Y)
  351 CONTINUE
C
C *** AREA SOURCE COMPUTATION
  441 IF(NBAR.EQ.0) GO TO 851
      SIGN=-1.D0
      I1=NBLN+1
      IEND=NBLN+NBAR
      DO 850 IXSC=I1,IEND
C
C     CHECK WHETHER THE CIRCLE CONTRIBUTES TO SITE ACCELERATION
      RIA=XXED(IXSC)
      HLIL=DP(IXSC)
      DIST=DSQRT((X-XXOR(IXSC))*(X-XXOR(IXSC))+(Y-YYOR(IXSC))*
     1  (Y-YYOR(IXSC)))
C
C *** DETERMINE WHETHER CIRCLE WILL BE CONSIDERED
      RMMX=3.75D0+XNBTP(IXSC)*.25D0
      RH=DIST-RIA
      IF(RH.LT.0.D0) RH=0.D0
      RH=DSQRT(RH*RH+HLIL*HLIL)
      YGCK=(B1*DEXP(B2*RMMX))/(RH+B4)**B3
      IF(YGCK.LT.YGMNCK) GO TO 850
C
C
      NR=RIA/DELTAC+0.9D0
      DR1=DELTAC*.5D0
C
C       ITERATION ON THE NB OF SEGMENTS IN THE CIRCLE
      DO 202 IR=1,NR
      DO 203 IS=1,2
      DR1=SIGN*DR1
      DLIL2=(DIST+DR1)*(DIST+DR1)
```

```
      AL=(RIA*RIA-DR1*DR1)
      IF(AL.LE.0.D0) GO TO 203
      AL=DSQRT(AL)
      RHIT2=DLIL2+HLIL*HLIL
C     COMPUTE EPICENTRAL DISTANCE RECK AT WHICH AN EARTHQUAKE
C     OF LARGEST MAGNITUDE RMMX WILL GENERATE AN ACCELERATION
C     YG(II)
C     IF RECK IS IMAGINARY OR SMALLER THAN DLIL, THE SOURCE IS
C     DISREGARDED.  OTHERWISE POINTS WHERE THE CONTRIBUTION BECOMES
C     ZERO ARE DETERMINED ON THE LINE.  SEGMENTS BEYOND THESE POINTS
C     ARE DISREGARDED.
      TERM=(B1*DEXP(B2*RMMX)/YGMNCK)**(1.D0/B3)
      IF((TERM-B4).LE.HLIL) GO TO 203
      TERM=(TERM-B4)*(TERM-B4)-(HLIL*HLIL)
C
C     THE EPICENTRAL DISTANCE IS NOT IMAGINARY
      IF(TERM.LE.DLIL2) GO TO 203
C     THE SEGMENT WILL BE PARTIALLY OR TOTALLY CONSIDERED
C
C     DETERMINE INTERSECTION BETWEEN RMMX AND THE SEGMENT
      AL1=DSQRT(TERM-DLIL2)
      IF(AL1.LT.AL)AL=AL1
C
      DUMMY=0.D0
      CALL INTGCL(IXSC,AL,DUMMY,RHIT2)
C
  203 CONTINUE
      DR1=DABS(DR1)
      DR1=DR1+DELTAC
  202 CONTINUE
C
  850 CONTINUE
  851 CONTINUE
C
C *** COMPUTE CDF OF EXCEEDING AT LEAST ONE TIME
      N1=100
      N2=101
      DO 442 I=1,99
      N1=N1-1
      N2=N2-1
      ACPDF(N1)=ACPDF(N1)*ACPDF(N2)
      DRPDF(N1)=DRPDF(N1)*DRPDF(N2)
      ACPDF(N2)=1.D0-ACPDF(N2)
  442 DRPDF(N2)=1.D0-DRPDF(N2)
      ACPDF(1)=1.D0-ACPDF(1)
      DRPDF(1)=1.D0-DRPDF(1)
      WRITE(6,2301)
 2301 FORMAT('0ACCELERATIONS')
      IST=1
      IED=10
      XIC=.02D0
      ACST=-.02D0
      DO 400 IS=1,3
      DO 410 IW=1,10
      XIX=IW
      ACUT(IW)=ACST+XIX*XIC
  410 CONTINUE
      WRITE(6,2300) ACUT
      WRITE(6,2300)(ACPDF(I),I=IST,IED)
 2300 FORMAT(' ',10F12.5)
      IST=IST+10
      IED=IED+10
      ACST=ACUT(10)
  400 CONTINUE
C
      WRITE(6,2302)
 2302 FORMAT('0DURATIONS')
      IST=1
      IED=10
      XIC=2.D0
      ACST=-2.D0
      DO 420 IS=1,3
      DO 430 IW=1,10
      XIX=IW
      ACUT(IW)=ACST+XIX*XIC
  430 CONTINUE
      WRITE(6,2300) ACUT
      WRITE(6,2300)(DRPDF(I),I=IST,IED)
      IST=IST+10
      IED=IED+10
      ACST=ACUT(10)
  420 CONTINUE
      IF(SKSAVE.EQ.1) GO TO 380
      WRITE(IWRT,2303)(ACPDF(I),I=1,30)
      WRITE(IWRT1,2303)(DRPDF(I),I=1,30)
 2303 FORMAT(10F8.5)
C
  380 X=X+DX
  385 Y=Y+DY
  365 CONTINUE
C
      RETURN
      END
      SUBROUTINE INITIA
C
C     ****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,UPAC,UPDR
      COMMON/ACVR/PBACAV(101),B1EB2M(20),PBDC(1000),PBZRDC(30,20)
     1 ,ACPDF(200),DRPDF(100),PBDRAV(51),DR50(20)
      COMMON/ACIN/IXACMN,NBACAV(101,3),NBDRAV(51,3)
C     ****************************************************************
C
      WRITE(6,2000) UPAC,UPDR
 2000 FORMAT('0UPPER LIMIT OF UNIFORM DISTRIBUTION',2F10.2)
C
C
C *** COMPUTE BAND & PROB OF UNIF. DISTRIBUTION FOR ACC
      XIC=.02D0
      DO 100 IX=1,101
      XIX=IX-1
      ACAV=XIX*XIC
      HIGH=ACAV*UPAC
      IXACED=(50.*HIGH)+1.5
      IXACST=IX+IX-IXACED
      NBACAV(IX,1)=IX
      NBACAV(IX,2)=IXACST
      NBACAV(IX,3)=IXACED
      XIXX=IXACED-IXACST+1
C
      PBACAV(IX)=1.D0/XIXX
C     WRITE(6,2010)IX,ACAV,PBACAV(IX),(NBACAV(IX,I),I=1,3)
```

```
C2010 FORMAT(' ',I5,2F14.5,3I10)
  100 CONTINUE
C
C *** COMPUTE BAND & PROB OF UNIF DISTRIBUTION FOR DURATION
      XIC=2.D0
      DO 110 IX=1,51
      XIX=IX-1
      ACAV=XIX*XIC
      HIGH=ACAV*UPDR
      IXACED=(.50*HIGH)+1.51
      IXACST=IX+IX-IXACED
      NBDRAV(IX,1)=IX
      NBDRAV(IX,2)=IXACST
      NBDRAV(IX,3)=IXACED
      XIXX=IXACED-IXACST+1
C
      PBDRAV(IX)=1.D0/XIXX
C     WRITE(6,2010)IX,ACAV,PBDRAV(IX),(NBDRAV(IX,I),I=1,3)
C2010 FORMAT(' ',I5,2F14.5,3I10)
  110 CONTINUE
      XXST=3.75D0
      XXIC=.25D0
      DO 200 IX=1,20
      XIX=IX
      XXMG=XXST+(XIX*XXIC)
      B1EB2M(IX)=B1*DEXP(B2*XXMG)
C     WRITE(6,2020)XXMG,B1EB2M(IX)
C2020 FORMAT(' ',F10.2,E15.7)
  200 CONTINUE
C
      IXACST=(50.D0*YGMN)+1.5D0
      DO 300 IX=2,30
      IXACMN=IX
      IF(NBACAV(IX,3).GT.IXACST) GO TO 310
  300 CONTINUE
  310 IXACMN=NBACAV(IXACMN-1,1)
C
      RETURN
      END
      SUBROUTINE BERNUI(IXSC,NBLN,TMRK,TMPR,XNPR,EVNB)
C
C
C
C     ****************************************************************
      IMPLICIT REAL*8 (A-H,P-Z)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,UPAC,UPDR
      COMMON/BRNUI/XNBEV(30),XNBTP(30),XNBMG(30,20)
      COMMON/ACVR/PBACAV(101),B1EB2M(20),PBOC(1000),PBZROC(30,20)
     1 ,ACPDF(200),DRPDF(100),PBDRAV(51),DR50(20)
      COMMON/GEOM/ XXOR(30),YYOR(30),XXED(30),YYED(30),DP(30),
     1  TMDA(30),XNBDA(30)
      DIMENSION PBMG(3,200),PBMGTT(3)
      LOGICAL*1 NONE
C     ****************************************************************
C
 1001 FORMAT(3F10.0,2I5)
C     INITIALIZE VARIABLES
      DO 101 IX=1,1000
  101 PBOC(IX)=0.D0
      DO 102 IX=1,200
      DO 102 I=1,3
  102 PBMG(I,IX)=0.D0
      DO 103 I=1,3
  103 PBMGTT(I)=0.D0
C
C *** SOURCE IXSC
C *** COMPUTE PROBABILITY OF 0,1,2...N OCCURRENCES OF ANY MAG
C *** ON THIS SOURCE.  REPLACE TOO SMALL PROB BY ZERO
C *** XNPR=NB OF OCC. IN TIME TMDA=TMPR= DATA BASE + BAYES
C *** TMRK = RISK PERIOD CONSIDERED
C *** NBOC= NB OF OCC. INCLUDING ZERO. NBOC=6*5 EVENTS
C
C     NORMALIZE RATE OF OCCURRENCES FOR DELTAL IN LINE SOURCES
      IF(IXSC.GT.NBLN) GO TO 220
      XLEN=DSQRT((XXOR(IXSC)-XXED(IXSC))*(XXOR(IXSC)-XXED(IXSC))+
     1 (YYOR(IXSC)-YYED(IXSC))*(YYOR(IXSC)-YYED(IXSC)))
      XNPR=(XNPR*DELTAL)/XLEN
      GO TO 210
C
C *** NORMALIZE RATE OF OCCURRENCE FOR AREA SOURCES
  220 XNPR=XNPR*DELTAC*DELTAL/(3.14159D0*XXED(IXSC)*XXED(IXSC))
C
  210 TMTT=TMRK+TMPR
C
C *** PROB OF ZERO OCC. ON THE SOURCE
C *** P(0)=(TMPR/TMTT)**XNPR
      PROB=XNPR*DLOG(TMPR/TMTT)
      IF(PROB.LT.-10.D0) GO TO 110
      PBOC(1)=DEXP(PROB)
  110 CONTINUE
      IXOC=0
      PBTT=PBOC(1)
C
C *** PROB OF 1,2,...N OCC. ON THE SOURCE
C *** PROB(N)=G(N+N')/(G(N+1)*G(N'))*T**N)*(T'**N')/(T+T')**(N+N')
      PBCT=XNPR*DLOG(TMPR)-DLGAMA(XNPR)
      DLTR=DLOG(TMRK)
      DLTT=DLOG(TMTT)
      NONE=.TRUE.
      IXST=1
      DO 120 N=1,999
      NBOC=N+1
      XN=N
      XNTT=XN+XNPR
      PROB=PBCT+DLGAMA(XNTT)-DLGAMA(XN+1.D0)+(XN*DLTR)-(XNTT*DLTT)
      IF(PROB.LT.-10.D0) GO TO 115
      PBOC(NBOC)=DEXP(PROB)
      PBTT=PBTT+PBOC(NBOC)
      NONE=.FALSE.
      GO TO 120
  115 IF(.NOT.NONE) GO TO 130
      IXST=IXST+1
  120 CONTINUE
  130 CONTINUE
      NBOC=NBOC-1
C
C *** INTRODUCE DATA ABOUT MAGNITUDE
C *** OBTAIN PROB OF 0,1,2,...N EVENTS FOR EACH OF THE NBMG MAG
C *** XETA = TOTAL NUMBER OF EVENTS
C *** XXXI = NUMBER OF EVENTS OF EACH MAG.
      NBMG=XNBTP(IXSC)+.5
      XETA=XNBEV(IXSC)
```

```
      DO 200 IXMG=1,NBMG
      XXXI=XNBMG(IXSC,IXMG)
C
C *** PBCT=G(ETA)/(G(XI)*G(ETA-XI))
      PBCT=DLGAMA(XETA)-DLGAMA(XXXI)-DLGAMA(XETA-XXXI)
C
C *** PROB OF ZERO SUCCESS  GIVEN N OCCUR.
C     P(O/N)=EXP(PBCT)*G(XI)*G(N+ETA-XI)/(G(N+ETA)
C *** PROB OF R SUCCESSES GIVEN N OCCUR.
C     P(R/N)=CNR*EXP(PBCT)*G(R+XI)*G(N+ETA-R-XI)/G(N+ETA)
      NBOC1=NBOC-1
      DO 300 N=IXST,NBOC1
      XTETT=0.D0
      XN=N
C *** PROB OF ZERO SUCCESS
      XNPR=XN+XETA-XXXI
      DEN=DLGAMA(XN+XETA)
      PROB=PBCT+DLGAMA(XXXI)+DLGAMA(XNPR)-DEN
      IF(PROB.LT.-10.D0) GO TO 300
      PBZROC(IXSC,IXMG)=PBZROC(IXSC,IXMG)+DEXP(PROB)*PBOC(N+1)
C     PBMG(IXMG,1)=PBMG(IXMG,1)+DEXP(PROB)*PBOC(N+1)
      XTEST=DEXP(PROB)
      XTETT=XTETT+XTEST
C     PBMGTT(IXMG)=PBMGTT(IXMG)+DEXP(PROB)*PBOC(N+1)
      GO TO 300
C
C *** DO LOOP ON THE NUMBER OF SUCCESSES
C *** TERMB=CNR
C *** PROB OF 1 SUCCESS GIVEN N OCCUR.
  305 TERMB=XN
      NONE=.TRUE.
      PROB=DLOG(TERMB)+PBCT+DLGAMA(1+XXXI)+DLGAMA(XNPR-1)-DEN
      IF(PROB.LT.-10.D0) GO TO 312
      PBMG(IXMG,2)=PBMG(IXMG,2)+DEXP(PROB)*PBOC(N+1)
      PBMGTT(IXMG)=PBMGTT(IXMG)+DEXP(PROB)*PBOC(N+1)
      XTEST=DEXP(PROB)
      XTETT=XTETT+XTEST
  312 IF(N.EQ.1)GO TO 300
C *** PROB OF 2,3,...N SUCCESSES GIVEN N OCCUR.
      DO 310 IR=2,N
      XI=N-IR+1
      XIR=IR
      TERMB=TERMB*XI/XIR
      DLTER=DLOG(TERMB)
      PROB=DLTER+PBCT+DLGAMA(XIR+XXXI)+DLGAMA(XNPR-XIR)-DEN
      IF(PROB.LT.-10.D0) GO TO 311
      PBMG(IXMG,IR+1)=PBMG(IXMG,IR+1)+DEXP(PROB)*PBOC(N+1)
      PBMGTT(IXMG)=PBMGTT(IXMG)+DEXP(PROB)*PBOC(N+1)
      XTEST=DEXP(PROB)
      XTETT=XTETT+XTEST
      NONE=.FALSE.
C     WRITE(6,2003)IR,PBMG(IXMG,IR+1)
      GO TO 310
  311 IF(.NOT.NONE) GO TO 300
  310 CONTINUE
  300 CONTINUE
C     PBTT=0.D0
C     DO 313 IX=1,NBOC
C     PBTT=PBTT+PBMG(IXMG,IX)
C 313 WRITE(6,2003)IX,PBMG(IXMG,IX)
C
C     WRITE(6,2003)IXMG,PBZROC(IXSC,IXMG)
      PBZROC(IXSC,IXMG)=1.D0-(PBZROC(IXSC,IXMG)+PBOC(1))
C
  200 CONTINUE
 2003 FORMAT(' ',I5,7G15.7)
      WRITE(6,2004)(PBZROC(IXSC,IXMG),IXMG=1,NBMG)
 2004 FORMAT(10F12.6)
C
      RETURN
      END
      SUBROUTINE CONSTL(IL,X,Y)
C
C     *****************************************************************
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER CASE
      COMMON/GEOM/ XXOR(30),YYOR(30),XXED(30),YYED(30),DP(30),
     1  TMDA(30),XNBDA(30)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,JPAC,JPOR
      COMMON/BRNUI/XNBEV(30),XNBTP(30),XNBMG(30,20)
C     *****************************************************************
C
C  AIL = SLOPE OF LINE DEFINED FY (X1,Y1),(X2,Y2)
C  BIL =  Y-INTERSEPT
C
C *** SET GEOMETRY LINE PARAMETERS
      XL1=XXOR(IL)
      YL1=YYOR(IL)
      XL2=XXED(IL)
      YL2=YYED(IL)
      DPIL=DP(IL)
      AIL=(YL2-YL1)/(XL2-XL1)
      BIL=YL1-AIL*XL1
      XBAR=(X+AIL*Y-BIL*AIL)/(AIL*AIL+1.0D0)
      YBAR=(AIL*X+Y*AIL*AIL+BIL)/(AIL*AIL+1.0D0)
      DLIL=DSQRT((X-XBAR)*(X-XBAR)+(Y-YBAR)*(Y-YBAR))
      RHIT2=DLIL*DLIL+DPIL*DPIL
C
C
      RMMX=3.75D0+XNBTP(IL)*.25D0
C *** THERE IS NO CUTOFF MAGNITUDE FOR THE SOURCE, SKIP FOLLWING ANALYSIS
C
C
C     COMPUTE EPICENTRAL DISTANCE RECK AT WHICH AN EARTHQUAKE
C     OF CUTOFF MAGNITUDE RMMX WILL GENERATE AN ACCELERATION
C     YG(II)
C     IF RECK IS IMAGINARY OR SMALLER THAN DLIL, THE SOURCE IS
C     DISREGARDED.  OTHERWISE POINTS WHERE THE CONTRIBUTION BECOMES
C     ZERO ARE DETERMINED ON THE LINE.  SEGMENTS BEYOND THESE POINTS
C     ARE DISREGARDED.
      TERM=(B1*DEXP(B2*RMMX)/YGMNCK)**(1.D0/B3)
      IF((TERM-B4).LE.DPIL) GO TO 830
      TERM=(TERM-B4)*(TERM-B4)-(DPIL*DPIL)
C
C     THE EPICENTRAL DISTANCE IS NOT IMAGINARY
      RECK=DSQRT(TERM)
      IF(RECK.LE.DLIL) GO TO 830
C
C     THE EPICENTRAL DISTANCE IS NOT SMALLER THAN DLIL,  POINTS OF
C     INTERSECTION WITH THE LINE ARE COMPUTED
      TERM1=AIL*(BIL-Y)-X
      TERM2=X*X+BIL*BIL+Y*(Y-2.D0*BIL)-RECK*RECK
```

```
      TERM3=AIL*AIL+1.D0
      TERM2=DSQRT(TERM1*TERM1-TERM2*TERM3)
C
C     COORDINATES OF THE POINTS OF INTERSECTION
      XI1=(-TERM1+TERM2)/TERM3
      XI2=(-TERM1-TERM2)/TERM3
      YI1=AIL*XI1+BIL
      YI2=AIL*XI2+BIL
      IF(XI1.LT.XI2) GO TO 150
      STOR=XI1
      XI1=XI2
      XI2=STOR
      STOR=YI1
      YI1=YI2
      YI2=STOR
  150 CONTINUE
C
C     CHECK WHETHER THE POINTS OF INTERSECTION ARE ON THE SEGMENT
C     CONSIDERED AND DETERMINE THE USE OF ALPHA AND BETA
C
      IF(XL1.LT.XI1) GO TO 800
      IF(XL1.GT.XI2) GO TO 830
      IF(XL2.GT.XI2) GO TO 820
C
      CASE=1
C *** SOURCE TOTALLY INCLUDED
      GO TO 850
C
  800 IF(XL2.LT.XI1) GO TO 830
      IF(XL2.LT.XI2) GO TO 840
C
      CASE=5
C *** SOURCE CUTOFF ON LEFT AND RIGHT ENDS
      XL2=XI2
      YL2=YI2
      GO TO 860
C
  830 CASE=3
C *** SOURCE TOTALLY DISREGARDED
      RETURN
C
  820 CASE=2
C *** SOURCE CUTOFF ON THE RIGHT END
      XL2=XI2
      YL2=YI2
      GOTO 850
C
  840 CASE=4
C *** SOURCE CUTOFF ON THE LEFT END
  860 XL1=XI1
      YL1=YI1
C
  850 CONTINUE
C
C     CHECK POSITION OF (XBAR,YBAR) ALONG LINE W.R.T. END
C     OF POINTS OF LINE SOURCE
      AL1=DSQRT((XL1-XBAR)*(XL1-XBAR)+(YL1-YBAR)*(YL1-YBAR))
      AL2=DSQRT((XL2-XBAR)*(XL2-XBAR)+(YL2-YBAR)*(YL2-YBAR))
      XLEN=DSQRT((XL2-XL1)*(XL2-XL1)+(YL2-YL1)*(YL2-YL1))
C
      IF(XBAR.GT.XL1) AL1=-AL1
      IF(XBAR.GT.XL2) AL2=-AL2
C
      CALL INTGLN(IL,XLEN,AL1,RHIT2)
      RETURN
      END
      SUBROUTINE INTGLN(IXSC,XLEN,AL,RHIT2)
C
C     ***************************.****************************************
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/ACVR/PBACAV(101),B1EB2M(20),PBOC(1000),PBZROC(30,20)
     1 ,ACPDF(200),DRPDF(100),PBDRAV(51),DR50(20)
      COMMON/ACIN/IXACMN,NBACAV(101,3),NBDRAV(51,3)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,JPAC,UPDR
      COMMON/BRNUI/XNBEV(30),XNBTP(30),XNBMG(30,20)
      DIMENSION ACUT(10)
C     ********************************************************************
C
      NBMG=XNBTP(IXSC)
      NBIC=(XLEN/DELTAL)+.5D0
      IF(NBIC.EQ.0) GO TO 110
C
C     START DO LOOP AT 1/2 DELTAL
      AL=AL+.5D0*DELTAL
C
      DO 100 IXIC=1,NBIC
      RH=RHIT2+AL*AL
      RHRT=DSQRT(RH)
      RH=(RHRT+B4)*(RHRT+B4)
      RHRT=RHRT*108.88D0
C
C     DO LOOP ON ALL POSSIBLE MAGNITUDES
      IXMG=NBMG+1
      DO 200 IX=1,NBMG
      IXMG=IXMG-1
      AC=B1EB2M(IXMG)/RH
      IXAC=(50.D0*AC)+1.5D0
C      PRINT,'IXAC,IXMG',AC,IXAC,IXMG
      IF(IXAC.LT.IXACMN) GO TO 100
      IXACPB=NBACAV(IXAC,1)
      IXACST=NBACAV(IXAC,2)
      IXACED=NBACAV(IXAC,3)
C
      PBZR=PBZROC(IXSC,IXMG)
      PROB=1.D0-(PBACAV(IXACPB)*PBZR)
C      PRINT,' 300',IXACPB,IXACST,PROB,PBACAV(IXACPB),PBZROC(IXSC,IXMG)
      DO 300 IXACVR=IXACST,IXACED
      ACPDF(IXACVR)=ACPDF(IXACVR)*PROB
  300 CONTINUE
C
C *** DURATIONS USING THE SAME VARIABLES AS ACC
      AC=DR50(IXMG)+.15D0*(50.D0-RHRT)
      IF(RHRT.GT.50.D0) AC=DR50(IXMG)/(.00112D0*(RHRT-50.D0)*
     1  (RHRT-50.D0)+1.D0)
      IXAC=AC*.5D0 + 1.51D0
      IXACPB=NBDRAV(IXAC,1)
      IXACST=NBDRAV(IXAC,2)
      IXACED=NBDRAV(IXAC,3)
C
      PROB=1.D0-(PBDRAV(IXACPB)*PBZR)
C
      DO 310 IXACVR=IXACST,IXACED
```

```
      DRPDF(IXACVR)=DRPDF(IXACVR)*PROB
  310 CONTINUE
C
  200 CONTINUE
  100 AL=AL+DELTAL
      DO 500 IX=1,100
      IF(ACPDF(IX).LT.1.D-5) ACPDF(IX)=0.D0
  500 CONTINUE
C
C
  110 CONTINUE
C     IST=1
C     IED=10
C     XIC=2.D0
C     ACST=-2.D0
C     DO 400 IS=1,3
C     DO 410 IX=1,10
C     XIX=IX
C     ACUT(IX)=ACST+XIX*XIC
C 410 CONTINUE
C     WRITE(6,1000) ACUT
C     WRITE(6,1000)(DRPDF(I),I=IST,IED)
C1000 FORMAT(' ',10F12.5)
C     IST=IST+10
C     IED=IED+10
C     ACST=ACUT(10)
C 400 CONTINUE
      RETURN
      END
      SUBROUTINE INTGCL(IXSC,XLEN,AL,RHIT2)
C
C     ************************************************************
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/ACVR/PBACAV(101),B1EB2M(20),PBOC(1000),PBZROC(30,20)
     1 ,ACPDF(200),DRPDF(100),PBDRAV(51),DR50(20)
      COMMON/ACIN/IXACMN,NBACAV(101,3),NBDRAV(51,3)
      COMMON/ATTEN/B1,B2,B3,B4,DELTAL,DELTAC,YGMN,YGMNCK,JPAC,JPDR
      COMMON/BRNUI/XNBEV(30),XNBTP(30),XNBMG(30,20)
      DIMENSION ACUT(10)
C     ************************************************************
C
      NBMG=XNBTP(IXSC)
      NBIC=(XLEN/DELTAL)+.5D0
      IF(NBIC.EQ.0) GO TO 110
C
C     START DO LOOP AT 1/2 DELTAL
      AL=AL+.5D0*DELTAL
C
      DO 100 IXIC=1,NBIC
      RH=RHIT2+AL*AL
      RHRT=DSQRT(RH)
      RH=(RHRT+B4)*(RHRT+B4)
      RHRT=RHRT*108.88D0
C
C     DO LOOP ON ALL POSSIBLE MAGNITUDES
      IXMG=NBMG+1
      DO 200 IX=1,NBMG
      IXMG=IXMG-1
C
C *** ACCELERATIONS
      AC=B1EB2M(IXMG)/RH
      IXAC=(50.D0*AC)+1.5D0
C      PRINT,'IXAC,IXMG',AC,IXAC,IXMG
      IF(IXAC.LT.IXACMN) GO TO 100
      IXACPB=NBACAV(IXAC,1)
      IXACST=NBACAV(IXAC,2)
      IXACED=NBACAV(IXAC,3)
C
      PBZR=PBZROC(IXSC,IXMG)
      PROB=1.D0-(PBACAV(IXACPB)*PBZR)
C      PRINT,' 300',IXACPB,IXACST,PROB,PBACAV(IXACPB),PBZROC(IXSC,IXMG)
      DO 300 IXACVR=IXACST,IXACED
      ACPDF(IXACVR)=ACPDF(IXACVR)*PROB*PROB
  300 CONTINUE
C
C *** DURATIONS USING THE SAME VARIABLES AS ACC
      AC=DR50(IXMG)+.15D0*(50.D0-RHRT)
      IF(RHRT.GT.50.D0) AC=DR50(IXMG)/(.00112D0*(RHRT-50.D0)*
     1  (RHRT-50.D0)+1.D0)
      IXAC=AC*.5D0 + 1.51D0
      IXACPB=NBDRAV(IXAC,1)
      IXACST=NBDRAV(IXAC,2)
      IXACED=NBDRAV(IXAC,3)
C
      PROB=1.D0-(PBDRAV(IXACPB)*PBZR)
C
      DO 310 IXACVR=IXACST,IXACED
      DRPDF(IXACVR)=DRPDF(IXACVR)*PROB*PROB
  310 CONTINUE
C
  200 CONTINUE
  100 AL=AL+DELTAL
C
      DO 500 IX=1,100
      IF(ACPDF(IX).LT.1.D-5) ACPDF(IX)=0.D0
      IF(DRPDF(IX).LT.1.D-5) DRPDF(IX)=0.D0
  500 CONTINUE
C
  110 CONTINUE
C     IST=1
C     IED=10
C     XIC=2.D0
C     ACST=-2.D0
C     DO 400 IS=1,3
C     DO 410 IX=1,10
C     XIX=IX
C     ACUT(IX)=ACST+XIX*XIC
C 410 CONTINUE
C     WRITE(6,1000) ACUT
C     WRITE(6,1000)(DRPDF(I),I=IST,IED)
C1000 FORMAT(' ',10F12.5)
C     IST=IST+10
C     IED=IED+10
C     ACST=ACUT(10)
C 400 CONTINUE
      RETURN
      END
//GO.FT10F001 DD UNIT=DISK,DCB=CARD,DSN=WYL.E1.G35.AG300,
//             DISP=(NEW,KEEP),SPACE=(3120,(20,5),RLSE),VOL=SER=PUB005
//GO.FT11F001 DD UNIT=DISK,DCB=CARD,DSN=WYL.E1.G35.DG300,
//             DISP=(NEW,KEEP),SPACE=(3120,(20,5),RLSE),VOL=SER=PUB005
//GO.SYSIN DD *
```

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C     ***************************************************************
C     PROGRAM PLOT.ISO                              STANFORD UNIVERSITY
C     ***************************************************************
C     THIS PROGRAM PLOTS THE ISO ACCELERATION OR ISO INTENSITY
C     LINES OVER A GRID (MAP) GIVEN THE ACCELERATIONS AT EACH NODE OF THE
C     GRID.  THE ORIGIN OF THE GRID IS THE BOTTOM LEFT CORNER, THE END
C     THE TOP RIGHT CORNER.  THE VALUES HAVE TO BE INPUT FILING COLUMNS
C     FROM BOTTOM TO TOP AS ONE MOVES FROM LEFT TO RIGHT : FIRST VALUE
C     INPUT IS THUS THE ORIGIN AND LAST THE END.
C     THE PLOT WILL BE ROTATED 90 DEGREES COUNTERCLOCWISE IF IT IS TOO
C     HIGH TO FIT ON THE PLOTTER.  IF BOTH DIMENSIONS ARE TOO BIG, AN
C     MESSAGE WILL BE GENERATED AND THE PLOT ABORTED.
C
C     ***************************************************************
C     INPUT FORMAT
C     ************
C
C      COL      VARIABLE NAME     VARIABLE DESCRIPTION
C
C     1.- IDENTIFICATION CARD   1 CARD   (80A1)
C      1-80     HED               RUN IDENTIFICATION
C
C     2.- PLOT FLAGS   1 CARD   (5I5,6F10.0)
C      1- 5     SKIPAC            =0, WILL PLOT ISO ACCELERATION LINES
C                                 =1, WILL PLOT ISO INTENSITY LINES
C      5-10     NF                NB OF FALUTS TO BE PLOTTED
C     11-15     NBPL              NB OF PLOTS
C     16-20     NR                NB OF ROWS IN INPUT
C     21-25     NC                NB OF COLUMNS IN INPUT
C     26-35     DX                DISTANCE (DEGREE) BETWEEN TWO COLUMNS
C     36-45     DY                DISTANCE (DEGREE) BETWEEN TWO ROWS
C     46-55     DC                INTERVAL BETWEEN TWO ISO LINES
C     56-65     XMDC              MULTIPLE OF CONTOUR TO BE LABELED (I2
C                                 FORMAT) FOR EXAMPLE IF XMDC=2.,
C                                 EVERY OTHER DC WILL BE LABELED
C
C     3.- GRID PARANETES   1 CARD   ((8F10.0)
C                                 THE ORIGIN OF THE GRID IS DEFINED AS
C                                 THE BOTTOM LEFT CORNER; THE END AS THE
C                                 TOP RIGHT.  THE VERTICAL HAS TO POINT
C                                 NORTH FOR THE DATA TO BE READ IN
C                                 CONSISTENTLY.
C      1-10     XMIN1             X COORD OF ORIGIN
C     11-20     YMIN1             Y COORD OF ORIGIN
C     21-30     XMAX1             X COORD OF END
C     31-40     YMAX1             Y COORD OF END
C     41-50     INDGX             LENGTH OF ONE DEGREE IN INCHES FOR
C                                 THE PLOT (X DIRECTION).
C     51-60     INDGY             LENGTH OF ONE DEGREEE IN INCHES FOR
C                                 THE PLOT (Y DIRECTION)
C     61-70     CAL               PLOTTER TO BE USED (11. OR 33.)
C                                 IF ZERO, WILL BE SET TO 11.
C     71-80     DIVR              THE FRAME COORDINATES ARE ROUNDED OFF
C                                 TO THE CLOSEST (DEGREE/DIVR)
C                                 IF INPUT AS 0, WILL BE SET TO 1
C
C     3.- FAULT COORDINATES   NF CARDS   (4F10.0) NO INPUT IF NF=0
C      1-10     YF1( )            Y COORD OF ORIGIN OF FAULT 1
C     11-20     XF1( )            X COORD OF ORIGIN OF FAULT 1
C     21-30     YF2( )            Y COORD OF END OF FAULT 1
C     31-40     XF2( )            X COORD OF END OF FAULT 2
C                                 REPEAT NF TIMES
C
C     4.- ACCELERATION AT THE NODES   8 VALUES PER CARD   (8F10.0)
C      1-10     ACC(1,IC)         ACC AT ORIGIN (IC=1)
C     ...       ACC(IR,IC)
C     ...       ACC(NR,IC)        ACC AT TOP OF FIRST COLUMN (IC=1)
C                                 REPEAT NC TIMES
C
C     OUTPUT
C     ******
C     A FILE IS CREATED ON DISK, IT HAS TO BE TRANSFERRED ON TAPE AND
C     PLOTTED ON A 11 OR 33 INCH CALCOMP PLOTTER
C
C     ***************************************************************
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      DIMENSION AMODES(200),END1(2),END2(2),XX(1000),YY(1000),A(1600)
     1,AA(40,40),XF1(20),XF2(20),YF1(20),YF2(20),HED1(20)
      INTEGER*4 NR,NC,ROTA,SKIPAC
      REAL RASIN,INDG,INDGX,INDGY
      LOGICAL*1 HED2(80)
      EQUIVALENCE(A(1),AA(1,1))
C     ***************************************************************
C
      READ(5,1001)HED1
 1001 FORMAT(20A4)
      WRITE(6,2202)HED1
 2202 FORMAT(' ',20A4)
      READ(5,1003)SKIPAC,NF,NBPL,NR,NC,DX,DY,DC,XMDC
      READ(5,1000)XMIN,YMIN,XMAX,YMAX,INDGX,INDGY,CAL,DIVR
      IF(DIVR.EQ.0.0) DIVR=1.
      IF(CAL.EQ.0.) CAL =11.
      PRINT,XMIN,YMIN,XMAX,YMAX,INDGX,INDGY,CAL,DIVR
      PRINT,NBPL,NR,NC,DX,DY,DC
C
 1000 FORMAT(8F10.0)
 1003 FORMAT(5I5,6F10.0)
      RASIN=100.
      ICAL=1
      IF(CAL.EQ.33.) RASIN=200.
      IF(CAL.EQ.33.)ICAL=2
C
C     DIVR IS USED TO TO BE ABLE TO PLOT PARTS OF DEGREES, USALLY DEGREE/10
      XMIN=IFIX(XMIN*DIVR+.5)
      YMIN=IFIX(YMIN*DIVR+.5)
      XMAX=IFIX(XMAX*DIVR+.5)
      YMAX=IFIX(YMAX*DIVR+.5)
      INDGX=INDGX/DIVR
      INDGY=INDGY/DIVR
      DX=DX*DIVR
      DY=DY*DIVR
      XRAS=(ABS(XMAX-XMIN)*INDGX+1.5)*RASIN
      YRAS=(ABS(YMAX-YMIN)*INDGY+1.5)*RASIN
      ROTA=0
C
C     ORIENTATE FRAME
      DELTAX=.75/INDGX
      DELTAY=.75/INDGY
      IF(YRAS.LE.(CAL*RASIN)) GO TO 100
      IF(XRAS.LE.(CAL*RASIN)) GO TO 110
      WRITE(6,2100)
```

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 2100 FORMAT('0THE SCALE IS TOO LARGE FOR THE PLOTTER, REDUCE INDG PER D
     &EGREE')
      STOP
C
C     INTERCHANGE X AND Y SCALES
  110 WRITE(6,2101)
 2101 FORMAT('0THE PLOT WILL BE ROTATED BY 90 DEGREES COUNTERCLOCKWISE')
      ROTA=1
      STOR=DX
      DX=DY
      DY=STOR
      STOR=DELTAX
      DELTAX=DELTAY
      DELTAY=STOR
      STOR=XMIN
      XMIN=YMAX
      YMAX=XMAX
      XMAX=YMIN
      YMIN=STOR
      STOR=XRAS
      XRAS=YRAS+3.5*RASIN
      YRAS=STOR
      IF(NF.EQ.0) GO TO 144
C
C     READ FAULTS
      READ(5,1007)(YF1(I),XF1(I),YF2(I),XF2(I),I=1,NF)
 1007 FORMAT(4F10.0)
C
      GO TO 130
C
  100 XRAS=XRAS+3.5*RASIN
C
      IF(NF.EQ.0) GO TO 144
      READ(5,1007)(XF1(I),YF1(I),XF2(I),YF2(I),I=1,NF)
C
C
  130 DO 143 I=1,NF
      XF1(I)=XF1(I)*DIVR
      YF1(I)=YF1(I)*DIVR
      XF2(I)=XF2(I)*DIVR
  143 YF2(I)=YF2(I)*DIVR
  144 CONTINUE
C
C     CHECK SIGNS
      IF(XMAX.GT.XMIN) GO TO 150
      XMAX=-XMAX
      XMIN=-XMIN
      IF(NF.EQ.0) GO TO 150
      DO 145 I=1,NF
      XF1(I)=-XF1(I)
  145 XF2(I)=-XF2(I)
C
  150 XFMAX=XMAX+DELTAX*4.25/.75
      XFMIN=XMIN-DELTAX
      IF(YMAX.GT.YMIN) GO TO 170
      YMAX=-YMAX
      YMIN=-YMIN
      IF(NF.EQ.0) GO TO 170
      DO 146 I=1,NF
      YF1(I)=-YF1(I)
  146 YF2(I)=-YF2(I)
C
  170 YFMAX=YMAX+DELTAY
      YFMIN=YMIN-DELTAY
C
C     FIND INTERSECTION BETWEEN FAULTS AND FRAME
      IF(NF.NE.0)CALL FRAME(NF,XMIN,YMIN,XMAX,YMAX,XF1,YF1,XF2,YF2)
C
      CALL STARTG(AMODES,ICAL,1,'L05BLK','L05BLK','L05BLK')
      AMODES(97)=XRAS
      AMODES(179)=YRAS
      IF(CAL.EQ.33.) AMODES(45)=AMODES(45)*1.5
      CALL OBJECG(AMODES,0.,0.,XRAS,YRAS)
      IF(ROTA.EQ.0) GO TO 610
      NSTOR=NC
      NC=NR
      NR=NSTOR
  610 CONTINUE
C
      DO 600 IP=1,NBPL
C
      CALL READ(AA,HED2,NR,NC,ROTA)
C
C     FIND LOWER AND UPPER CONTOUR VALUES
      NBVL=NR*NC
      CALL LIMITS(A,NBVL,SKIPAC,CMIN,DC,CMAX)
C
      AMODES(50)=0.
      AMODES(46)=0.
      CALL SUBJEG(AMODES,XFMIN,YFMIN,XFMAX,YFMAX)
C
      WRITE(6,2102)AMODES(12),AMODES(13)
 2102 FORMAT('0THE SCALES ARE ',2E16.5)
C
C     PLOT GRID
      END1(1)=IFIX(YMIN)
      END2(1)=IFIX(XMAX)
      END1(2)=IFIX(YMAX)
      END2(2)=IFIX(XMIN)
C
      DELTA2=1./(8.*INDGX)
      XMUL=4.
      DELTA1=4.*DELTA2
      DELTA3=3.*DELTA2
      DELTA4=1.5*AMODES(40)*AMODES(45)/(RASIN*INDGX)
      DELTA5=2.0*DELTA4
      SIGN=-1.
C
      I=1
      VAR=END1(2)
      FIX=END2(2)
C
      DO 400 K=1,2
C
  401 XX(I)=FIX
      YY(I)=VAR
      XX(I+1)=FIX+DELTA2
      YY(I+1)=VAR
      XX(I+2)=FIX
      YY(I+2)=VAR
      XVAR=ABS(VAR/DIVR)
      INTG=XVAR+.01
```

```
      XC=FIX-DELTA2*XMUL
      YC=VAR
C
      IF(IFIX(XVAR+.91).EQ.INTG)CALL  INUMBG(AMODES,XC,YC,2,INTG)
      I=I+3
      IF(VAR.EQ.END1(K))  GO TO 402
      VAR=VAR+SIGN
      GO TO 401
C
  402 STOR=VAR
      VAR=FIX
      FIX=STOR
  404 XX(I)=VAR
      YY(I)=FIX
      XX(I+1)=VAR
      YY(I+1)=FIX+DELTA2
      XX(I+2)=VAR
      YY(I+2)=FIX
      XVAR=ABS(VAR/DIVR)
      INTG=XVAR+.01
      XC=VAR-DELTA4
      YC=FIX-DELTA3
C
      IF(IFIX(XVAR+.91).EQ.INTG)CALL  INUMBG(AMODES,XC,YC,3,INTG)
      I=I+3
      IF(VAR.EQ.END2(K))  GO TO 403
      VAR=VAR-SIGN
      GO TO 404
C
  403 SIGN=-SIGN
      STOR=VAR
      VAR=FIX
      FIX=STOR
      DELTA2=-DELTA2
      XMUL=2.
      DELTA3=-DELTA3
C
  400 CONTINUE
C     DO 500 K=1,I
C 500 WRITE(6,550)XX(K),YY(K)
  550 FORMAT(' ',2F10.3, I6,F10.3)
      I=I-3
      CALL LINESG(AMODES,I,XX,YY)
C
C     PLOT TITLE
      XT=XFMAX - 3.*DELTAX
      AMODES(50)=90.
      AMODES(46)=90.
      YT=YMIN+DELTA1
      CALL  VECSG(AMODES,XT,YT,48,HED2)
C
      IF(NF.EQ.0) GO TO 142
C     PLOT FAULTS
C
      PRINT,'FAULTS AS THEY ARE PLOTTED'
      WRITE(6,2011)(I,XF1(I),YF1(I),XF2(I),YF2(I),I=1,NF)
 2011 FORMAT(' ',I5,4F10.3)
      CALL  SEGMTG(AMODES,NF,XF1,YF1,XF2,YF2)
  142 CONTINUE
C
C     CHANGE SUBJECT SPACE TO PLOT CONTOURS, THE BOTTOM LEFT CORNER
```

```
C     HAS TO HAVE (0.,0.) COORDINATES
      XFMAX1=ABS(XFMAX-XFMIN)-DELTAX
      YFMAX1=ABS(YFMAX-YFMIN)-DELTAY
      PRINT,'DELTAX,DELTAY,XFMAX,YFMAX',DELTAX,DELTAY,XFMAX,YFMAX
      XFMIN1=-DELTAX
      YFMIN1=-DELTAY
C
      PRINT,'RASOR,XRAS,YRAS',RASOR,XRAS,YRAS
      CALL  SUBJEG(AMODES,XFMIN1,YFMIN1,XFMAX1,YFMAX1)
      PRINT,'SCALE',AMODES(12),AMODES(13)
C
C     CREATE COUNTOURS AND PLOT THEM
      AMODES(45)=AMODES(45)*.6
      CALL  CONTUR(AMODES,AA,NR,NC,DC,XMDC,DELTA5)
      AMODES(45)=AMODES(45)/.6
C
      CALL  PICTRG(AMODES)
  600 CONTINUE
C
      CALL  EXITG(AMODES)
      RETURN
      END
      SUBROUTINE READ(AA,HED2,NROW,NCOL,NROT)
C
C     ******************************************************************
      DIMENSION AA(NROW,NCOL)
      LOGICAL*1 HED2(80)
C     ******************************************************************
C
C     THIS SUBROUTINE READS THE DATA TO BE INTERPOLATED
      READ(5,1002)HED2
 1002 FORMAT(80A1)
C
      IF(NROT.EQ.1)  GO TO 110
C
C     THE DATA IS STORED IN A TWO DIMENSIONAL ARRAY, A(1,1) BEING AT
C     THE ORIGIN OF THE PLOT (BOTTOM LEFT CORNER)
C
      DO 100 IR=1,NROW
  100 READ(5,1000)(AA(IR,IC),IC=1,NCOL)
      GO TO 99
C
C     THE PLOT HAS BEEN ROTATED BY 90 DEGREES COUNTERCLOCKWISE,
C     THE ROWS AND COLUMNS ARE INVERTED IN THE CALL STATEMENT
  110 CONTINUE
      DO 200 I=1,NCOL
      IC=NCOL+1-I
  200 READ(5,1000)(AA(IR,IC),IR=1,NROW)
   99 CONTINUE
C
      DO 300  IR=1,NROW
  300 WRITE(6,1001)(AA(IR,IC),IC=1,NCOL)
 1001 FORMAT(' ',13F10.3)
 1000 FORMAT(8F10.5)
C
      RETURN
      END
      SUBROUTINE LIMITS(A,NBVL,SKIPAC,CMIN,DC,CMAX)
C
C     ******************************************************
      DIMENSION  A(1)
```

```
      INTEGER SKIPAC
C     **********************************************************;
C
C     SEARCH FOR LOW BOUND
      IF(SKIPAC.NE.1) GO TO 110
C
C     FIND INTENSITIES USING RICHTER GUTENBERG RELATIONSHIP
      DO 99 IV  =1,NBVL
      A(IV)=3.*(ALOG10(A(IV)*1000.)+.5)
   99 CONTINUE
C
  110 CONTINUE
      XLOW=A(1)
      DO 100 IV=2,NBVL
      IF(A(IV).LT.XLOW) XLOW=A(IV)
  100 CONTINUE
C
C     SEARCH FOR UPPER BOUND
      XHIGH=A(1)
      DO 200 IV=2,NBVL
      IF(A(IV).GT.XHIGH) XHIGH=A(IV)
  200 CONTINUE
C
C     FIND LOW AND HIGH CONTOUR LINES TO BE PLOTTED
      CMIN=-DC
  300 CMIN=CMIN+DC
      IF(CMIN.LT.XLOW) GO TO 300
C
      CMAX=CMIN-DC
  400 CMAX=CMAX+DC
      IF(CMAX.LT.XHIGH) GO TO 400
      CMAX=CMAX-DC
C
      PRINT,'XLOW,XHIGH,CMIN,CMAX',XLOW,XHIGH,CMIN,CMAX
C
      RETURN
      END
      SUBROUTINE FRAME(NF,XMIN,YMIN,XMAX,YMAX,XF1,YF1,XF2,YF2)
C
C     ****************************************************************
      DIMENSION XF1(1),XF2(1),YF1(1),YF2(1)
C     ****************************************************************
C
C     LIMIT THE FAULTS TO THE AREA UNDER CONSIDERATION
      DO 500 IF=1,NF
C
C     CHECK THE X COORDINATES OF THE FAULT
      SIGN=1.
      CHECK=XMIN
C
C     CHECK FOR LOWER AND UPPER BORN
      DO 100 K=1,2
      XF=XF1(IF)*SIGN
C
C     CHECK FOR ORIGIN AND END OF SEGMENT
      DO 200 I=1,2
      IF(XF.GE.CHECK) GO TO 200
      ASL=(YF1(IF)-YF2(IF))/(XF1(IF)-XF2(IF))
      BET=YF1(IF)-ASL*XF1(IF)
      IF(I.EQ.2) GO TO 300
C
C     CHANGE COORDINATES
      XF1(IF)=SIGN*CHECK
      YF1(IF)=ASL*XF1(IF)+BET
      GO TO 200
  300 XF2(IF)=SIGN*CHECK
      YF2(IF)=ASL*XF2(IF)+BET
  200 XF=XF2(IF)*SIGN
      SIGN=-1.
  100 CHECK=-XMAX
C
C     CHECK THE Y COORDINATES OF THE FAULT
      SIGN=1.
      CHECK=YMIN
C
C     CHECK FOR LOWER AND UPPER BORN
      DO 110 K=1,2
      YF=YF1(IF)*SIGN
C
C     CHECK FOR ORIGIN AND END OF SEGMENT
      DO 210 I=1,2
      IF(YF.GE.CHECK) GO TO 210
      ASL=(YF1(IF)-YF2(IF))/(XF1(IF)-XF2(IF))
      BET=YF1(IF)-ASL*XF1(IF)
      IF(I.EQ.2) GO TO 310
C
C     CHANGE COORDINATES
      YF1(IF)=SIGN*CHECK
      XF1(IF)=(YF1(IF)-BET)/ASL
      GO TO 210
  310 YF2(IF)=SIGN*CHECK
      XF2(IF)=(YF2(IF)-BET)/ASL
  210 YF=YF2(IF)*SIGN
      SIGN=-1.
  110 CHECK=-YMAX
C
  500 CONTINUE
      RETURN
      END
      SUBROUTINE CONTUR(AMODES,FXY,IRDM,ICDM,CTIC,XMDC,DELTA5)
C
C *** PASS A SET OF MESH POINTS FXY(IRDM,ICDM) WITH INCREMENTS
C *** OF DX AND DY FOR AN AREA OF SEARCH IRDM, ICDM WITH
C *** ORIGIN AT THE BOTTOM LEFT CORNER.  FIND A SPECIFIC
C *** CONTOUR LEVEL CTLV
C
      DIMENSION FXY(IRDM,ICDM),AMODES(200)
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
     1 ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
      LOGICAL*1 OPEN
C
C *** SEARCH GRID FOR SMALLEST AND LARGEST VALUE
C *** SET VALUES OF CONTOURS TO BE PLOTTED
      PTLVAD=XMDC*CTIC
      PTLV=PTLVAD
      DSMN=(DX*DX+DY*DY)
      OFPOLY=SQRT(DSMN)*.0001
      XINC=SQRT(DSMN)*.05
      DSMN=DSMN*.02
      OFFSET=CTIC*.001
      ERROR=CTIC*.01
```

```
      IORDER=3
      NBPTIT=4
      CTLW=FXY(1,1)
      CTHG=FXY(1,1)
      DO 21 IR=1,IRDM
      DO 21 IC=1,ICDM
      CTCK=FXY(IR,IC)
      IF(CTCK.LT.CTLW)CTLW=CTCK
      IF(CTCK.GT.CTHG)CTHG=CTCK
   21 CONTINUE
C
C *** DETERMINE FIRST CONTOUR TO BE LABELLED
      IF(XMDC.EQ.0.) GO TO 300
      DO 310 IX=1,100
      IF(PTLV.GE.CTLW) GO TO 301
  310 PTLV=PTLV+PTLVAD
  301 CONTINUE
C
      IF(CTIC.GT.1.) GO TO 300
      PTLV=PTLV*100.
      PTLVAD=PTLVAD*100.
  300 CONTINUE
C
C *** DETERMINE NUMBER OF CONTOURS
      NBCT=CTLW/CTIC
      IF(NBCT.GT.-1) NBCT=NBCT+1
      CTLV=FLOAT(NBCT)*CTIC
      NBHG=CTHG/CTIC
      IF(NBHG.LT.0) NBHG=NBHG-1
      NBCT=NBHG-NBCT+1
C*    CTLV=.4
C*    NBCT=1
      PRINT,'LW,HG,IC,NBCT',CTLW,CTHG,CTIC,CTLV,NBCT
      DO 9 IR=1,IRDM
      WRITE(6,111)(FXY(IR,IC),IC=1,ICDM)
    9 CONTINUE
  111 FORMAT(' ',10F10.2)
C
C *** FIND EACH CONTOUR, STARTING WITH SMALLEST CTLV
      DO 26 IXCT=1,NBCT
      PRINT,'&&&&&&&&&&&&&&&&&  CONTOUR    ******************',CTLV
C
C *** CHECK IF ANY NODE HAS A VALUE EQUAL TO CTLV, IF SO CHANGE BY OFFSET
      DO 22 IR=1,IRDM
      DO 22 IC=1,ICDM
      IF(FXY(IR,IC).EQ.CTLV) FXY(IR,IC)=FXY(IR,IC)+OFFSET
   22 CONTINUE
C
C *** SEARCH ALONG BOUNDARIES FOR SQUARES CONTAINING CONTOUR EXTREMETIES
      NBCV=0
      NBPT=0
      NBSQ=0
      NBSQFR=0
      IRMX=IRDM-1
      ICMX=ICDM-1
C
C *** SEARCH ALONG VERTICAL BOUNDARIES
      IC=1
      IKBD=0
      DO 100 IP=1,2
      DO 110 IR=1,IRMX
```

```
      IF((FXY(IR,IC).LT.CTLV.AND.FXY(IR+1,IC).LT.CTLV).OR.
     1   (FXY(IR,IC).GT.CTLV.AND.FXY(IR+1,IC).GT.CTLV)) GO TO 110
      NBSQ=NBSQ+1
      IXSQBD(NBSQ)=IKBD*IRMX+IR
  110 CONTINUE
      IC=ICDM
  100 IKBD=ICMX-1
C
C *** SEARCH ALONG HORIZONTAL BOUNDARIES
      IR=1
      IKBD=0
      DO 120 IP=1,2
      DO 130 IC=1,ICMX
      IF((FXY(IR,IC).LT.CTLV.AND.FXY(IR,IC+1).LT.CTLV).OR.
     1   (FXY(IR,IC).GT.CTLV.AND.FXY(IR,IC+1).GT.CTLV)) GO TO 130
      NBSQ=NBSQ+1
      IXSQBD(NBSQ)=(IC-1)*IRMX+IR-IKBD
  130 CONTINUE
      IR=IRDM
  120 IKBD=1
      IF(NBSQ.EQ.0) GO TO 151
C
C *** START SEARCH WITH BOUNDARY SQUARES CONTAINING CONTOUR EXTREMITIES
      DO 150 IXSQ=1,NBSQ
      IC=(IXSQBD(IXSQ)-1)/IRMX
      IR=IXSQBD(IXSQ)-IC*IRMX
      IC=IC+1
C
C *** CHECK IF SQUARE HAS ALREADY BEEN SEARCHED.  IN THIS PART OF THE
C *** PROBLEM ALL THE SEARCHES ARE SUCCESSFUL AND SEARCH GOES FROM
C *** SQUARE TO SQUARE.  ONLY FURTHER IS SEARCH EXHAUSTIVE
      IF(NBPT.EQ.0) GO TO 161
      DO 160 IXPT=1,NBPT
      IF(ISQROW(IXPT).EQ.IR.AND.ISQCOL(IXPT).EQ.IC) GO TO 150
  160 CONTINUE
  161 CONTINUE
C
C *** THIS SQUARE IS THE FIRST OF THE CURVE.  TWO INTERSECTIONS SHOULD
C *** BE FOUND : ONE WITH BOUNDARY AND THE OTHER LEADING TO THE SEARCH
C *** WITHIN THE GRID
C    1 IR,IC,IRMX,ICMX
      CALL SQUAR(FXY,IRDM,ICDM,IR,IC,0,CTLV)
C
      IP=NBPTSQ+1
      GO TO (150,11,12,11,14 ),IP
C
C *** ONE OR THREE POINTS: END CURVE
   11 NBCV=NBCV+1
      IXCVST(NBCV)=-(NBPT-IP+1)
      GO TO 150
C
C *** FOUR POINTS, SKIP THE SQUARE AT THIS TIME NOT TO START
C *** SEARCH WITH FOUR POINT SQUARE
   14 NBPT=NBPT-4
      GO TO 150
C
C *** TWO POINTS : CHECK WHICH ONE IS ON THE BOUNDARY.  SET IT FIRST
C *** IN ARRAY.  START SEARCH WITHIN THE GRID
   12 IPTBND=0
      DO 15 IP=1,2
      IF((IR.EQ.1.AND.ISIDE(IP).EQ.1).OR.
```

```
     1    (IR.EQ.IRMX.AND.ISIDE(IP).EQ.3).OR.
     2    (IC.EQ.1.AND.ISIDE(IP).EQ.4).OR.
     3    (IC.EQ.ICMX.AND.ISIDE(IP).EQ.2))IPTBND=IPTBND+IP
   15 CONTINUE
C
      IP=IPTBND+1
      GO TO (30,31,32,31),IP
      GO TO 150
C
C *** THE SECOND POINT IS ON THE BOUNDARY
   32 STORX=CONTX(NBPT)
      STORY=CONTY(NBPT)
      CONTX(NBPT)=CONTX(NBPT-1)
      CONTY(NBPT)=CONTY(NBPT-1)
      CONTX(NBPT-1)=STORX
      CONTY(NBPT-1)=STORY
      ISIDE(2)=ISIDE(1)
C
C *** THE FIRST POINT IS ON THE BOUNDARY (OR BOTH, IP=3)
C *** SET COUNTER TO NEGATIVE VALUE SINCE CURVE IS OPEN
   31 NBCV=NBCV+1
      IXCVST(NBCV)=-(NBPT-1)
      IS=ISIDE(2)
C
      CALL SEARCH(FXY,IRDM,ICDM,IR,IC,IS,NBCV,CTLV)
C
C *** SEARCH FOR PRESENT CURVE COMPLETE.  GO TO NEXT CURVE
C *** AT SAME CTLV
C
      ICNT=IABS(IXCVST(NBCV))
      GO TO 150
C
  150 CONTINUE
  151 CONTINUE
C
C *** SEARCH EXHAUSTIVELY THE REMAINING SQUARES
      DO 170 ICDO=1,ICMX
      DO 170 IRDO=1,IRMX
      IC=ICDO
      IR=IRDO
C
C *** TEST IF THE SQUARE HAS BEEN SEARCHED BEFORE
      IF(NBPT.EQ.0)GO TO 172
      DO 171 IXPT=1,NBPT
      IF(ISQROW(IXPT).EQ.IR.AND.ISQCOL(IXPT).EQ.IC) GOTO 170
  171 CONTINUE
  172 CONTINUE
C
      CALL SQUAR(FXY,IRDM,ICDM,IR,IC,0,CTLV)
C
      IF(NBPTSQ.NE.2) GO TO 170
      NBCV=NBCV+1
      IXCVST(NBCV)=NBPT-1
      IS=ISIDE(2)
C
      CALL SEARCH(FXY,IRDM,ICDM,IR,IC,IS,NBCV,CTLV)
      ICNT=IABS(IXCVST(NBCV))
C
  170 CONTINUE
C
C *** KEEP LAST POINT + 1 IN MEMORY
```

```
      IXCVST(NBCV+1)=NBPT+1
C
C *** ALL THE CURVES CORRESPONDING TO THIS CTLV ARE DETERMINED
C *** START PLOTTING, IF NBCV.EQ.0 SKIP PLOTTING
      IF(NBCV.EQ.0) GO TO 10
C
C *** REPLACE POINTS THAT TOO CLOSE TOGETHER BY THEIR AVERAGES
      IXST=IXCVST(1)
      IXSK=0
      DO 200 IXCV=1,NBCV
      OPEN=.FALSE.
      IXED=IABS(IXCVST(IXCV+1))-1
      IF(IXST.GT.0) GO TO 250
      OPEN=.TRUE.
      IXST=-IXST
  250 STXX=CONTX(IXST)
      STYY=CONTY(IXST)
      IXKP=IXST-IXSK
      IXST=IXST+1
C
C *** CHECK DISTANCE BETWEEN POINTS OF THE SAME CURVE
      DO 210 IX=IXST,IXED
      IXNW=IX-IXSK-1
      DXX=CONTX(IX)-STXX
      DYY=CONTY(IX)-STYY
      IF((DXX*DXX)+(DYY*DYY).GT.DSMN) GO TO 220
      CONTX(IXNW)=STXX+.5*DXX
      CONTY(IXNW)=STYY+.5*DYY
      STXX=CONTX(IXNW)
      STYY=CONTY(IXNW)
      IXSK=IXSK+1
      GO TO 210
C
  220 CONTX(IXNW)=STXX
      CONTY(IXNW)=STYY
      STXX=CONTX(IX)
      STYY=CONTY(IX)
  210 CONTINUE
C
      IF(OPEN) GO TO 225
      DXX=CONTX(IXKP)-CONTX(IXED)
      DYY=CONTY(IXKP)-CONTY(IXED)
      IF((DXX*DXX+DYY*DYY).GT.DSMN) GO TO 225
      CONTX(IXKP)=CONTX(IXKP)-.5*DXX
      CONTY(IXKP)=CONTY(IXKP)-.5*DYY
      IXSK=IXSK+1
C
C *** STORE LAST POINT OF CURVE AND START NEW ONE
  225 CONTX(IXNW+1)=CONTX(IXED)
      CONTY(IXNW+1)=CONTY(IXED)
      IXCVCK=IXCVST(IXCV+1)
      IXST=IXCVCK
      IF(IXCVCK.GT.0)IXCVCK=IXCVCK-IXSK
      IF(IXCVCK.LT.0) IXCVCK=IXCVCK+IXSK
      IXCVST(IXCV+1)=IXCVCK
      IXPP=IABS(IXCVCK)-1
  200 CONTINUE
C
C *** PLOT THE CURVES, CHECK WHETHER LEVEL VALUES SHOULD BE PLOTTED
      INLV=0
      IF(PTLV.EQ.0.) GO TO 201
```

```
      CTCK=CTLV
      IF(CTIC.LT.1.) CTCK=CTCK*100.
      IF(CTCK.LT.PTLV) GO TO 201
      INLV=CTCK+.1
      PTLV=PTLV+PTLVAD
  201 CALL PLOT(AMODES,NBCV,INLV,XINC,DELTAS)
   10 CONTINUE
C
      CTLV=CTLV+CTIC
   26 CONTINUE
      RETURN
      END
      SUBROUTINE SEARCH(FXY,IRDM,ICDM,IR,IC,IS,NBCV,CTLV)
C
C *** THE SUBROUTINE STARTS WITH A RECTANGLE HAVING ONE INTERSECTION WITH
C *** WITH CONTOUR AND SEARCHES THE WHOLE CONTOUR
C
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
     1  ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
      DIMENSION FXY(IRDM,ICDM)
C
C *** DETERMINE NEXT SQUARE TO SEARCH
   20 CONTINUE
      GO TO (31,32,33,34),IS
   31 IR=IR-1
      GO TO 35
   32 IC=IC+1
      GO TO 35
   33 IR=IR+1
      GO TO 35
   34 IC=IC-1
C
C *** TEST IF THE SQUARE IS WITHIN THE MESH.  IF NOT END CUREVE
C *** START NEXT CURVE FOR SAME CTLV
   35 CONTINUE
      IF(IC.LT.1.OR.IC.GT.(ICDM-1).OR.IR.LT.1.OR.IR.GT.(IRDM-1))GO TO 9
C
C *** DETERMINE IF CURVE CLOSES ON ITSELF.  IF SO DELETE LAST POINT
C *** (SAME AS FIRST), END CURVE AND GO TO NEXT ONE FOR SAME CTLV
      ISCK=IABS(IXCVST(NBCV))
      IF(IR.EQ.ISQROW(ISCK).AND.IC.EQ.ISQCOL(ISCK))
     1  GO TO 8
C
C *** DETERMINE SIDE NOT TO BE SEARCHED IN NEXT SQUARE
      ISKIP=IS+2
      IF(ISKIP.GT.4)ISKIP=ISKIP-4
C
C *** SEARCH NEXT SQUARE
      CALL SQUAR(FXY,IRDM,ICDM,IR,IC,ISKIP,CTLV)
C
      IP=NBPTSQ+1
      GO TO (7,11,7,6),IP
C
C *** NO POINTS ARE FOUND, THERE IS A PROBLEM
C *** END CURVE AND GO TO THE NEXT ONE FOR THE SAME CTLV
C
C *** ONE POINT FOUND, FLAG THE SIDE AND CONTINUE SEARCH
   11 IS=ISIDE(1)
      GO TO 20
      GO TO 10
C
C *** CHANGE INDEX OF FIRST POINT ON THE CURVE TO LAST SQUARE
C *** SUCH THAT EACH SQUARE IS FLAGGED(FOR EXHAUSTIVE SEARCH)
      ISQROW(ISCK)=ISQROW(NBPT)
      ISQCOL(ISCK)=ISQCOL(NBPT)
      NBPT=NBPT-1
      GO TO 10
      GO TO 10
      CALL FOURPT(IR,IC,ISKIP)
      IS=ISIDE(1)
      GO TO 20
C
C *** TWO POINTS ARE FOUND THERE IS A PROBLEM
C
C *** THREE POINTS ARE FOUND : TWO CURVES IN THE SAME SQUARE
C *** CALL ROUTINE TO HANDLE THAT PROBLEM
C
C
   10 RETURN
      END
      SUBROUTINE FOURPT (IR,IC,ISKIP)
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
     1  ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
      DIMENSION XX(3),YY(3),DIST(2),IRFR(20),ICFR(20),ISFR1(20),
     1  ISFR2(20)
      DG=90./1.57095
      NBPT=NBPT-3
C
C *** TRANSFER LAST 3 POINTS IN SMALL ARRAY
      DO 10 IX=1,3
      XX(IX)=CONTX(NBPT+IX)
   10 YY(IX)=CONTY(NBPT+IX)
C
C *** CHECK IF THIS RECTANGLE HAS BEEN SEARCHED
      IF(NBSQFR.EQ.0) GO TO 11
      DO 20 IX=1,NBSQFR
      IXSQ=IX
      IF(IR.EQ.IRFR(IXSQ).AND.IC.EQ.ICFR(IXSQ)) GO TO 30
   20 CONTINUE
C
C *** THIS SQUARE HAS NOT BEEN SEARCHED, REJECT THE POINT
C *** OPPOSITE TO ISKIP AND CHOOSE THE ONE CLOSEST TO THE
C *** STRAIGHT LINE (NBPT-1)-(NBPT)
   11 ISOP=ISKIP+2
      IF(ISOP.GT.4) ISOP=ISOP-4
C
C *** MOVE THE 2 POINTS NOT OPPOSITE IN XX,YY 1 AND 2
      DO 40 IX=1,2
      IF(ISIDE(IX).NE.ISOP) GO TO 40
      XX(IX)=XX(3)
      YY(IX)=YY(3)
      ISIDE(IX)=ISIDE(3)
      GO TO 50
   40 CONTINUE
C
C *** COMPUTE ANGLE, CHOOSE SMALLEST
   50 X2=CONTX(NBPT)
      Y2=CONTY(NBPT)
      X1=CONTX(NBPT-1)
      Y1=CONTY(NBPT-1)
```

```
      DXX=X2-X1
      DYY=Y2-Y1
      IF(DXX.EQ.0.) GO TO 100
      A1=ATAN(DYY/DXX)
      A1DG=A1*DG
      GO TO 110
C
C *** THE SEGMENT IS VERTICAL A1=90.
  100 A1=1.57095
C
C *** COMPUTE DIFFERENCE OF SLOPES BETWEEN PREVIOUS 2 POINTS (SEGMENT)
C *** AND SGMENT (NBPT, NBPT+1)
  110 DO 130 IX=1,2
      XC=XX(IX)
      YC=YY(IX)
      A2=ATAN((YC-Y2)/(XC-X2))
      A2DG=A2*DG
      DIST(IX)=ABS(A2-A1)
      DSDG=DIST(IX)*DG
  130 CONTINUE
C
C *** CHOOSE SMALLEST ONE, STORE REJECTED POINTS FOR LATER
      IXCK=1
      IF(DIST(1).GT.DIST(2)) IXCK=2
      NBPT=NBPT+1
      CONTX(NBPT)=XX(IXCK)
      CONTY(NBPT)=YY(IXCK)
C
C *** STORE INFORMATION FOR LATER
      NBSQFR=NBSQFR+1
      IRFR(NBSQFR)=IR
      ICFR(NBSQFR)=IC
      IX=1
      IF(IXCK.EQ.1) IX=2
      ISFR1(NBSQFR)=ISOP
      ISFR2(NBSQFR)=ISIDE(IX)
      ISIDE(1)=ISIDE(IXCK)
      GO TO 99
C
C *** THIS RECTANGLE HAS ALREADY BEEN SEARCHED.  TWO POINTS HAVE
C *** BEEN CHOSEN.  CHOOSE THE ONE DIFFERENT FROM ISKIP
   30 ISCK=ISFR1(IXSQ)
      IF(ISKIP.EQ.ISCK)ISCK=ISFR2(IXSQ)
      DO 60 IX=1,3
      IXPT=IX
      IF(ISCK.EQ.ISIDE(IXPT)) GO TO 70
   60 CONTINUE
C
C *** STORE THE POINT IN VECTOR
   70 NBPT=NBPT+1
      CONTX(NBPT)=XX(IXPT)
      CONTY(NBPT)=YY(IXPT)
      ISIDE(1)=ISIDE(IXPT)
C
   99 RETURN
      END
      SUBROUTINE SQUAR(FXY,IRDM,ICDM,IR,IC,ISKIP,CTLV)
      DIMENSION FXY(IRDM,ICDM)
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
     1  ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
```

```
      NBPTSQ=0
      DO 20 IS=1,4
      IF (IS.EQ.ISKIP) GO TO 20
      GO TO (11,12,13,14), IS
   11 IF ((FXY(IR,IC+1).LT.CTLV.AND.FXY(IR,IC).LT.CTLV).OR.
     1   (FXY(IR,IC+1).GT.CTLV.AND.FXY(IR,IC).GT.CTLV)) GO TO 20
      NBPT = NBPT+1
      NBPTSQ=NBPTSQ+1
      ISIDE(NBPTSQ) = 1
      CALL INTRP(FXY,IRDM,ICDM,IR,IC,1,CTLV,XINTER)
      CONTX(NBPT)=XINTER
      CONTY (NBPT) = (IR-1)*DY
      GO TO 10
   12 IF ((FXY(IR+1,IC+1).LT.CTLV.AND.FXY(IR,IC+1).LT.CTLV).OR.
     1   (FXY(IR+1,IC+1).GT.CTLV.AND.FXY(IR,IC+1).GT.CTLV)) GO TO 20
      NBPT = NBPT+1
      NBPTSQ=NBPTSQ+1
      ISIDE(NBPTSQ) = 2
      CALL INTRP(FXY,IRDM,ICDM,IR,IC,2,CTLV,XINTER)
      CONTY(NBPT)=XINTER
      CONTX (NBPT) = IC*DX
      GO TO 10
   13 IF ((FXY(IR+1,IC+1).LT.CTLV.AND.FXY(IR+1,IC).LT.CTLV).OR.
     1   (FXY(IR+1,IC+1).GT.CTLV.AND.FXY(IR+1,IC).GT.CTLV)) GO TO 20
      NBPT = NBPT+1
      NBPTSQ=NBPTSQ+1
      ISIDE(NBPTSQ) = 3
      CALL INTRP(FXY,IRDM,ICDM,IR,IC,3,CTLV,XINTER)
      CONTX(NBPT)=XINTER
      CONTY (NBPT) = IR*DY
      GO TO 10
   14 IF ((FXY(IR+1,IC).LT.CTLV.AND.FXY(IR,IC).LT.CTLV).OR.
     1   (FXY(IR+1,IC).GT.CTLV.AND.FXY(IR,IC).GT.CTLV)) GO TO 20
      NBPT = NBPT+1
      NBPTSQ=NBPTSQ+1
      ISIDE(NBPTSQ) = 4
      CALL INTRP(FXY,IRDM,ICDM,IR,IC,4,CTLV,XINTER)
      CONTY(NBPT)=XINTER
      CONTX (NBPT) = (IC-1)*DX
   10 ISQROW(NBPT)=IR
      ISQCOL(NBPT)=IC
C
   20 CONTINUE
      RETURN
      END
      SUBROUTINE INTRP(FXY,IRDM,ICDM,IR,IC,IS,CTLV,XINTER)
      COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPOLY
      COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
     1  ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
      REAL FXY(IRDM,ICDM),MESH,X(10,5),QR(10,5),A(5),DUM(10),F(5)
C
C *** DETERMINE REFERENCE CONER, DIRECTION OF INTERPOLATION
C *** AND MESH BOUNDARIES
      GO TO (1,2,1,2),IS
C
C *** HORIZONTAL SIDE
    1 MESH=DX
      IREF=IC
      IFCT=IR
      IBND=ICDM
      GO TO 5
```

```
C
C *** VERTICAL SIDE
    2 MESH=DY
      IREF=IR
      IFCT=IC
      IBND=IRDM
C
C *** CHECK THAT ALL INTERPOLATION POINTS ARE WITHIN THE MESH
C *** IF NOT END INTERPOLATION AT THE BOUNDARY AND DECREASE
C *** CORRESPONDINGLY THE ORDER OF THE POLYNONMIAL
    5 IPAD=(NBPTIT-2)/2
      ILOW=IREF-IPAD
      IHGH=IREF+IPAD+1
      IF(ILOW.LT.1)ILOW=1
      IF(IHGH.GT.IBND)IHGH=IBND
      NPTS=IHGH-ILOW+1
      IORDMX=NPTS+1-(NBPTIT-IORDER)
      IF(IORDMX.EQ.0)IORDMX=1
C
C *** DETERMINE SIDE INDEX AND EVALUATE POLYNOMIAL AT THE POINTS
      IF(IS.EQ.2.OR.IS.EQ.3)IFCT=IFCT+1
      ICNT=0
      DO 10 IXPT=ILOW,IHGH
      ICNT=ICNT+1
      X(ICNT,1)=1.
      IF(IORDMX.LT.2) GO TO 7
      DO 6 IORD=2,IORDMX
    6 X(ICNT,IORD)=(FLOAT(ICNT-1)*MESH)**(IORD-1)
    7 CONTINUE
      GO TO (11,12,11,12),IS
   11 F(ICNT)=FXY(IFCT,IXPT)
      GO TO 10
   12 F(ICNT)=FXY(IXPT,IFCT)
   10 CONTINUE
C
C *** CALL SOLVER
      CALL LSQ (X,QR,A,F,DUM,NPTS,10,IORDMX,5,1,&30)
      XINTER = (FLOAT(IREF-ILOW)+.5)*MESH
C
C *** EVALUATE POLYNOMIAL AT A FIRST GUESSED POINT AND
C *** OBTAIN ROOT BY INTERATION (CHECK AGAINST ERROR)
      IORDMX=IORDMX-1
      DO 20 ICNT=1,20
      DERVFP = A(2)
      FPOLY = A(1)
      DO 21 I = 1,IORDMX
      FPOLY = FPOLY + A(I+1)*XINTER**(I)
   21 CONTINUE
      DO 22 I=2,IORDMX
      DERVFP = DERVFP +FLOAT(I)*A(I+1)*XINTER**(I-1)
   22 CONTINUE
      DIFF=CTLV-FPOLY
      IF (ABS(DIFF).LT.ERROR) GO TO 25
      XINTER = XINTER + DIFF /DERVFP
   20 CONTINUE
   25 XINTER=XINTER+FLOAT(ILOW-1)*MESH
      GO TO 31
   31 RETURN
      END
      SUBROUTINE LSQ(A,QR,X,B,AXBNRM,M,MDIM,N,NDIM,P,*)
      INTEGER M,N,P,PIVOT(100),MDIM,NDIM,I,J,K
```

```
      REAL A(MDIM,N),X(NDIM,P),B(MDIM,P),QR(MDIM,N),ALPHA(100),Y(100),
     1E(100),R(100),DBL*8,DBLSUM*8,YNORM,ENORM,AXBNRM(P),RNRSQ
C     DO 100 I=1,M
      DO 1 J=1,N
        DO 1 I=1,M
    1     QR(I,J)=A(I,J)
      CALL DCP(M,MDIM,N,QR,ALPHA.PIVOT,&30)
      DO 10 K=1,P
      AXBNRM(K)=-1.
        DO 2 I=1,M
    2     R(I)=B(I,K)
        CALL SLV(M,MDIM,N,QR,ALPHA,PIVOT,R,Y)
        DO 3 I=1,M
               DBLSUM=-B(I,K)
               DO 33 J=1,N
               DBL=A(I,J)
   33          DBLSUM=DBLSUM + DBL*Y(J)
    3     R(I)=-DBLSUM
        CALL SLV(M,MDIM,N,QR,ALPHA,PIVOT,R,E)
      YNORM=0.
      ENORM=0.
        DO 4 I=1,N
          YNORM=YNORM + Y(I)**2
    4     ENORM=ENORM + E(I)**2
        IF(ENORM.GT.YNORM*0.0625) GO TO 10
    5   DO 6 I=1,N
    6     Y(I) = Y(I) + E(I)
        DO 7 I=1,M
               DBLSUM = -B(I,K)
               DO 77 J=1,N
               DBL=A(I,J)
   77          DBLSUM=DBLSUM+DBL*Y(J)
    7     R(I)=-DBLSUM
        CALL SLV(M,MDIM,N,QR,ALPHA,PIVOT,R,E)
        ENORM=0.
        DO 8 I=1,N
    8     ENORM=ENORM + E(I)**2
        IF(ENORM.GT.1.58E-8*YNORM) GO TO 5
        DO 9 I=1,N
          X(I,K) = Y(I)
    9  CONTINUE
        RNRSQ=0.
        DO 11 I=1,M
   11   RNRSQ=RNRSQ+R(I)**2
      AXBNRM(K)=SQRT(RNRSQ)
   10 CONTINUE
      RETURN
   30 RETURN1
      END
      SUBROUTINE SLV(M,MDIM,N,QR,ALPHA,PIVOT,R,Y)
      INTEGER M,N,PIVOT(100),PIVOTI,MDIM,I,J,IJ,II,I1,NMIN1
      REAL QR(MDIM,N),ALPHA(N),R(M),Y(100),Z(100),DBL*8,DBLSUM*8,GAMMA
      DO 1 J=1,N
               DBLSUM=0.
               DO 11 I=J,M
               DBL=QR(I,J)
   11          DBLSUM=DBLSUM+DBL*R(I)
        GAMMA=DBLSUM/(ALPHA(J)*QR(J,J))
        DO 12 IJ=J,M
   12     R(IJ)=R(IJ)+GAMMA*QR(IJ,J)
    1 CONTINUE
```

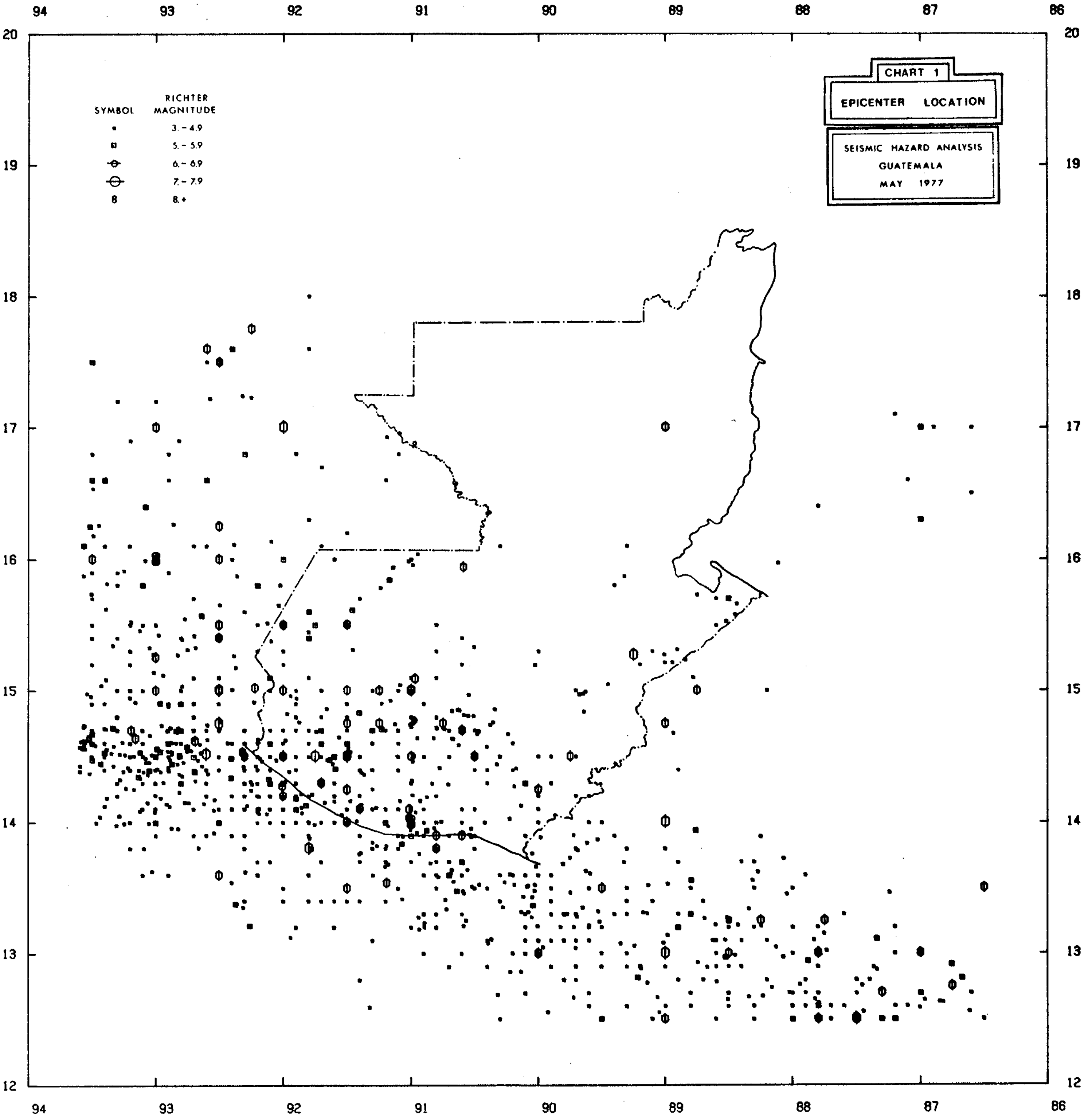
```
   Z(N)=R(N)/ALPHA(N)
   NMIN1=N-1
   DO 2 II=1,NMIN1
     I=N-II
     I1=I+1
            DBLSUM=-R(I)
            DO 22 J=I1,N
            DBL=QR(I,J)
22          DBLSUM=DBLSUM + DBL*Z(J)
 2   Z(I)=-DBLSUM/ALPHA(I)
   DO 3 I=1,N
     PIVOTI =PIVOT(I)
 3   Y(PIVOTI)=Z(I)
   RETURN
   END
   SUBROUTINE DCP(M,MDIM,N,QR,ALPHA,PIVOT,*)
   INTEGER M,N,PIVOT(100),MDIM,I,J,K,JBAR,K1
   REAL QR(MDIM,N),ALPHA(N),SUM(100),Y(100),DBLSUM*8,DBL*8,BETA,
  1 SIGMA,ALPHAK,QRKK
   DO 1 J=1,N
   PIVOT(J)=J
   DBLSUM = 0.
            DO 11 I=1,M
            DBL = QR(I,J)
11          DBLSUM = DBLSUM + DBL**2
 1 SUM(J)=DBLSUM
   DO 8 K=1,N
     SIGMA = SUM(K)
     JBAR = K
     IF(K.EQ.N) GO TO 5
     K1=K+1
     DO 2 J=K1,N
       IF(SIGMA.GE.SUM(J))GO TO 2
       SIGMA = SUM(J)
       JBAR = J
 2     CONTINUE
 3     IF(JBAR.EQ.K)GO TO 5
       I=PIVOT(K)
       PIVOT(K)=PIVOT(JBAR)
       PIVOT(JBAR)=I
       SUM(JBAR)=SUM(K)
       SUM(K)=SIGMA
       DO 4 I=1,M
         SIGMA= QR(I,K)
         QR(I,K)= QR(I,JBAR)
 4       QR(I,JBAR)=SIGMA
 5          DBLSUM=0.
            DO 55 I=K,M
            DBL=QR(I,K)
55          DBLSUM=DBLSUM+DBL**2
       SIGMA=DBLSUM
       IF(SIGMA.EQ.0.) RETURN1
       QRKK=QR(K,K)
       ALPHAK=SQRT(SIGMA)
       IF(QRKK.GE.0.)ALPHAK=-ALPHAK
      ALPHA(K)=ALPHAK
       QR(K,K)=QRKK-ALPHAK
       BETA=1./(SIGMA-QRKK*ALPHAK)
   IF(K.EQ.N) GO TO 8
       DO 6  J=K1,N
       DBLSUM=0.
```

```
              DO 66 I=K,M
              DBL=QR(I,K)
 66           DBLSUM=DBLSUM+DBL*QR(I,J)
  6      Y(J)=BETA*DBLSUM
         DO 7 J=K1,N
           DO 72 I=K,M
 72          QR(I,J) = QR(I,J)-QR(I,K)*Y(J)
  7        SUM(J)=SUM(J)-QR(K,J)**2
  8 CONTINUE
    RETURN
    END
    SUBROUTINE PLOT(AMODES,NBCV,INLV,XINC,DELTA5)
    COMMON /PLTT/ CONTX(100),CONTY(100),DX,DY,ERROR,OFPJLY
    COMMON NBPT,NBPTSQ,ISIDE(4),IORDER,NBPTIT,NBSQFR,
   1  ISQROW(100),ISQCOL(100),IXCVST(20),IXSQBD(20)
    DIMENSION AMODES(200)
    DIMENSION CNTX(100),CNTY(100),XX(3),YY(3)
    DIMENSION TPXN(100),TPYN(100),TPXO(100),TPYO(100)
   1 ,TPXNM(100),TPYNM(100),TPXOM(100),TPYOM(100)
    LOGICAL*1 OPEN,SKIP,NOAVG,VERTI,LEVEL
    DEG=180./3.14159
    PI=3.14159
    PI2=3.14159*.5
C
C *** DO LOOP ON THE NUMBER OF CURVES AT THIS CTLV
    DO 100 IXCV=1,NBCV
C
C
C *** DETERMINE CURVE PARAMETERS (OPEN,CLOSE,FIRST AND LAST POINT)
    LEVEL=.FALSE.
    IF(INLV.NE.0) LEVEL=.TRUE.
    OPEN=.FALSE.
    SKIP=.TRUE.
    IXST=IXCVST(IXCV)
    IXLW=IXST
    IXAD=1
    IF(IXST.LT.0) OPEN=.TRUE.
    IF(.NOT.OPEN) GO TO 109
    IXAD=-1
    SKIP=.FALSE.
    NOAVG=.TRUE.
109 IXST=IABS(IXST)
    IXHG=IABS(IXCVST(IXCV+1))-1
C
C *** IF CURVE HAS TWO POINTS OR LESS, DO NOT PLOT
    NBPTCV=IXHG-IXST
    ILPT=0
    IF(NBPTCV.LT.2) GO TO 100
    IF(NBPTCV.LT.5)LEVEL=.FALSE.
    IF(NBPTCV.GT.5) ILPT=NBPTCV/2
    IF(NBPTCV.GT.20)ILPT=NBPTCV/3
    IXLT=IXHG+IXAD
    XOROD=0.
    YOROD=0.
    WW=0.
    WWNW=1.
    WWOD=0.
    XXOD=0.
    YYOD=0.
    SLOD=0.
    SNOD=0.
```

```
      CSOD=0.
      IPIC=0
C
C *** TRANFER THE POINTS OF INTEREST INTO A SMALL ARRAY
  110 IXED=IXST
      IPIC=IPIC+1
      IF(IXED.GT.IXHG)IXED=IXLW
      DO 300 IX=1,3
      XX(IX)=CONTX(IXED)
      YY(IX)=CONTY(IXED)
      IXED=IXED+1
      IF(IXED.GT.IXHG) IXED=IXLW
  300 CONTINUE
C
C *** OPERATE TRANFER OF AXIS
      XXMD=(XX(3)+XX(1))*.5
      YYMD=(YY(3)+YY(1))*.5
      YYDU=YYMD-YY(2)
      XXDU=XX(2)-XXMD
C
C *** CHECK IF AXIS SHOULD BE VERTICAL
      IF(ABS(YYDU).GE.OFPOLY) GO TO 310
      SLNW=PI2
C
C *** IF MD AND 2 COINCIDE, THE SLOPE IS TO BE DETERMINED
C *** BETWEEN MD AND 1
      IF(ABS(XXDU).GE.OFPOLY) GO TO 311
      YYDU=YYMD-YY(1)
      XXDU=XX(1)-YYMD
      IF(ABS(YYDU).GE.OFPOLY)SLNW=ATAN(XXDU/YYDU)
      GO TO 311
C
  310 SLNW=ATAN(XXDU/YYDU)
C
C *** DETERMINE COORDINATES OF THE THREE POINTS IN NEW SYTEM
  311 XORNW=XX(1)
      YORNW=YY(1)
      CSNW=COS(SLNW)
      SNNW=SIN(SLNW)
      XX2= (XX(2)-XX(1))*CSNW+(YY(2)-YY(1))*SNNW
      IF(ABS(XX2).LT.OFPOLY) XX2=SIGN(OFPOLY,XX2)
      YY2=-(XX(2)-XX(1))*SNNW+(YY(2)-YY(1))*CSNW
      YY3=-(XX(3)-XX(1))*SNNW+(YY(3)-YY(1))*CSNW
      IF((YY2-.5*YY3).EQ.0.) YY2=YY2+OFPOLY
C
      SLDNW=SLNW*DEG
C
C *** OBTAIN THE COEFFICIENTS OF THE 2 ORDER POLYNOMIAL
C *** PASSING THROUGH THE 3 POINTS, A1NW=0.
      A2NW=(2.*YY2-.5*YY3)/XX2
      A3NW=(.5*YY3-YY2)/(XX2*XX2)
C
C *** IF THIS IS THE FIRST LEG OF A CLOSED CURVE, GO TO NEXT POINT
      IF(SKIP) GO TO 120
C
C *** IN NEW AXIS, OBTAIN NUMBER OF INCREMENTS (NBIC), INCREMENT
C *** SIZE (XXIC), COORD OF POINT ON CURVE (XXNW,YYNW), TRANFER
C *** TO MAIN AXIS (CNTX(),CNTY()).
C *** IN OLD (PREVIOUS) SYSTEM, FIND THE CORRESPONDING OF X COORDINATE
C *** (XXOD) OF XXNW,YYNW. OBTAIN THE INTERSECTION OF THE VERTICAL AT
C *** AT XXOD WITH THE OLD CURVE XXOD,YYOD.  TRANFER THE INTERSECTION
```

```
C *** TO THE MAIN SYSTEM.  OBTAIN WEITHTED AVERAGES CNTX(),CNTY()
C *** XXOD,YYOD AND XXNW,YYNW
  400 XXBG=0.
      IPT=1
      NBIC=ABS(XX2/XINC)+1
      XNBIC=NBIC
C
C *** DETERMINE WEIGHTING FACTOR AND ANGLE OF NEW WITH RESPECT
C *** TO OLD SYSTEM
      IF(NOAVG) GO TO 430
      IF(NBIC.EQ.0) GO TO 430
      WW=1./XNBIC
      WWOD=1.-WW
      WWNW=WW
      SLNO=SLNW-SLOD
      SLDNO=SLNO*DEG
      CSNO=COS(SLNO)
      SNNO=SIN(SLNO)
C
C *** DETERMINE IN OLD SYSTEM THE SLOPE OF THE VERTICAL IN NEW
      VERTI=.TRUE.
      IF(SLNO.EQ.0..OR.ABS(SLNO).EQ.PI) GO TO 430
      VERTI=.FALSE.
      AVT=TAN(SLNO+PI2)
      SLVT=SLNO+PI2
      SLDVT=SLVT*DEG
C
C *** DETERMINE INTERSECTIONS IN NEW AXIS
  430 CNTX(1)=XX(IPT)
      CNTY(1)=YY(IPT)
      NBICTT=NBIC+1
      IF(NBIC.LT.2) GO TO 410
      XXIC=XX2/XNBIC
      DO 420 IXIC=2,NBIC
      XXNW=XXBG+FLOAT(IXIC-1)*XXIC
      YYNW=A3NW*XXNW*XXNW+A2NW*XXNW
      TPXN(IXIC)=XXNW
      TPYN(IXIC)=YYNW
C
      TPXNM(IXIC)=XORNW+XXNW*CSNW-YYNW*SNNW
      TPYNM(IXIC)=YORNW+XXNW*SNNW+YYNW*CSNW
C *** DO NOT AVERAGE IF IT IS THE FIRST OR LAST LEG OF AN OPEN CURVE
      IF(NOAVG) GO TO 480
C
C *** DETERMINE THE COORD OF XXNW,0. IN OLD SYSTEM TO OBTAIN
C *** THE B COEFF. (BVT) IN OLD OF VERTICAL IN NEW
      XXOD=DXNO+XXNW*CSNO
      IF(VERTI) GO TO 425
      YYOD=DYNO+XXNW*SNNO
      BVT=YYOD-AVT*XXOD
      AA=AVT-A2OD
      RTAD=(SQRT(AA*AA+4.*A3OD*BVT))/(2.*A3OD)
      AA=AA*.5/A3OD
      XXOD=AA+RTAD
      XXXX=AA-RTAD
      IF(XXOD.LT.0.) GO TO 426
      IF((XXOD.LT.DXNO).OR.
     1  (XXOD.GT.(DXX3)))XXOD=AA-RTAD
      GO TO 425
C
  426 IF((XXOD.GT.DXNO).OR.
```

```
     1  (XXOD.LT.(DXX3)))XXOD=AA-RTAD
  425 YYOD=A3OD*XXOD*XXOD+A2OD*XXOD
C
C *** TRANFER TO MAIN AXIS
  480 TPXO(IXIC)=XXOD
      TPYO(IXIC)=YYOD
      TPXOM(IXIC)=XOROD+XXOD*CSOD-YYOD*SNOD
      TPYOM(IXIC)=YOROD+XXOD*SNOD+YYOD*CSOD
      CNTX(IXIC)=WWNW*(XORNW+XXNW*CSNW-YYNW*SNNW)+
     1           WWOD*(XOROD+XXOD*CSOD-YYOD*SNOD)
      CNTY(IXIC)=WWNW*(YORNW+XXNW*SNNW+YYNW*CSNW)+
     1           WWOD*(YOROD+XXOD*SNOD+YYOD*CSOD)
C
C *** COMPUTE NEW WEIGHTS
  419 WWNW=WWNW+WW
      WWOD=WWOD-WW
  420 CONTINUE
  410 CNTX(NBICTT)=XX(IPT+1)
      CNTY(NBICTT)=YY(IPT+1)
C
C *** PLOT ARRAY OF NBIC POINTS GOING FROM IXST TO IXST+1
C*     WRITE(6,1000)(TPXN(I),TPYN(I),I=2,NBIC)
C*     WRITE(6,1000)(TPXO(I),TPYO(I),I=2,NBIC)
C*     WRITE(6,1000)(TPXNM(I),TPYNM(I),I=2,NBIC)
C*     WRITE(6,1000)(TPXOM(I),TPYOM(I),I=2,NBIC)
C*    WRITE(6,1000)(CNTX(I),CNTY(I),I=1,NBICTT)
 1000 FORMAT(' ',10F10.3)
      IF(.NOT.LEVEL) GO TO 119
C *** WRITE CONTOUR LEVEL
      IF(XX(2).EQ.0..OR.IPIC.LT.ILPT) GO TO 119
      XLAB=DELTA5*DELTA5
      IF((XX(2)*XX(2)+YY(2)*YY(2)).LT.XLAB) GO TO 119
      IPIC=0
      XXCK=XX(IPT+1)
      YYCK=YY(IPT+1)
      DO 125 IX=2,NBICTT
      IXCK=NBICTT-IX+1
      DELTA=(XXCK-CNTX(IXCK))*(XXCK-CNTX(IXCK))+
     1      (YYCK-CNTY(IXCK))*(YYCK-CNTY(IXCK))
      IF(DELTA.GT.XLAB) GO TO 126
  125 CONTINUE
C
  126 ANGL=ATAN((CNTY(IXCK)-YYCK)/(CNTX(IXCK)-XXCK))
      AMODES(50)=ANGL*180./3.14159
      AMODES(46)=AMODES(50)
      XLDY=DELTA5/1.5
      XLDX=XLDY
C
      IXLB=IXCK
C     IF(XX2.LT.0.)IXLB=NBICTT
      XXLB=CNTX(IXLB)+XLDX*COS(ANGL)
      YYLB=CNTY(IXLB)+XLDY*SIN(ANGL)
      CALL INJMBG(AMODES,XXLB,YYLB,2,INLV)
C
      NBICTT=IXCK
      IF(NBICTT.LT.2) GO TO 120
  119 CALL LINESG(AMODES,NBICTT,CNTX,CNTY)
C
C *** MOVE TO NEXT POINT
C *** STORE PARAMETERS FROM NW TO OD
  120 IXST=IXST+1
      A2OD=A2NW
      A3OD=A3NW
      XOROD=XORNW
      YOROD=YORNW
      SLOD=SLNW
      CSOD=CSNW
      SNOD=SNNW
      DXNO=XX2
      DYNO=YY2
      DXX3=2.*XX2
      SKIP=.FALSE.
      NOAVG=.FALSE.
C
C *** CHECK WHERE ONE IS ON THE CURVE
      IF(IXST-IXLT) 110,150,100
C
C *** 110 : MIDDLE OF CURVE, CONTINUE INTERPOLATION
C
C *** LAST LEG
C *** IF (OPEN) DO NOT INTERPOLATE, USE PRESENT A'S AND PLOT
C *** IF (.NOT.OPEN) AVERAGE PRESENT A'S WITH A*ST
  150 CONTINUE
      IF(.NOT.OPEN) GO TO 110
      XXBG=XX2
      IPT=2
      NOAVG=.TRUE.
      WWNW=1.
      WWOD=0.
      WW=0.
      GO TO 430
C
C *** END OF CURVE, START NEXT ONE
  100 CONTINUE
      RETURN
      END
$DATA
```

CHART 1
EPICENTER LOCATION
SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977
SYMBOL
RICHTER MAGNITUDE
3.-4.9
5.-5.9
6.-6.9
7.-7.9
8
8.+
94
93
92
91
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86
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12

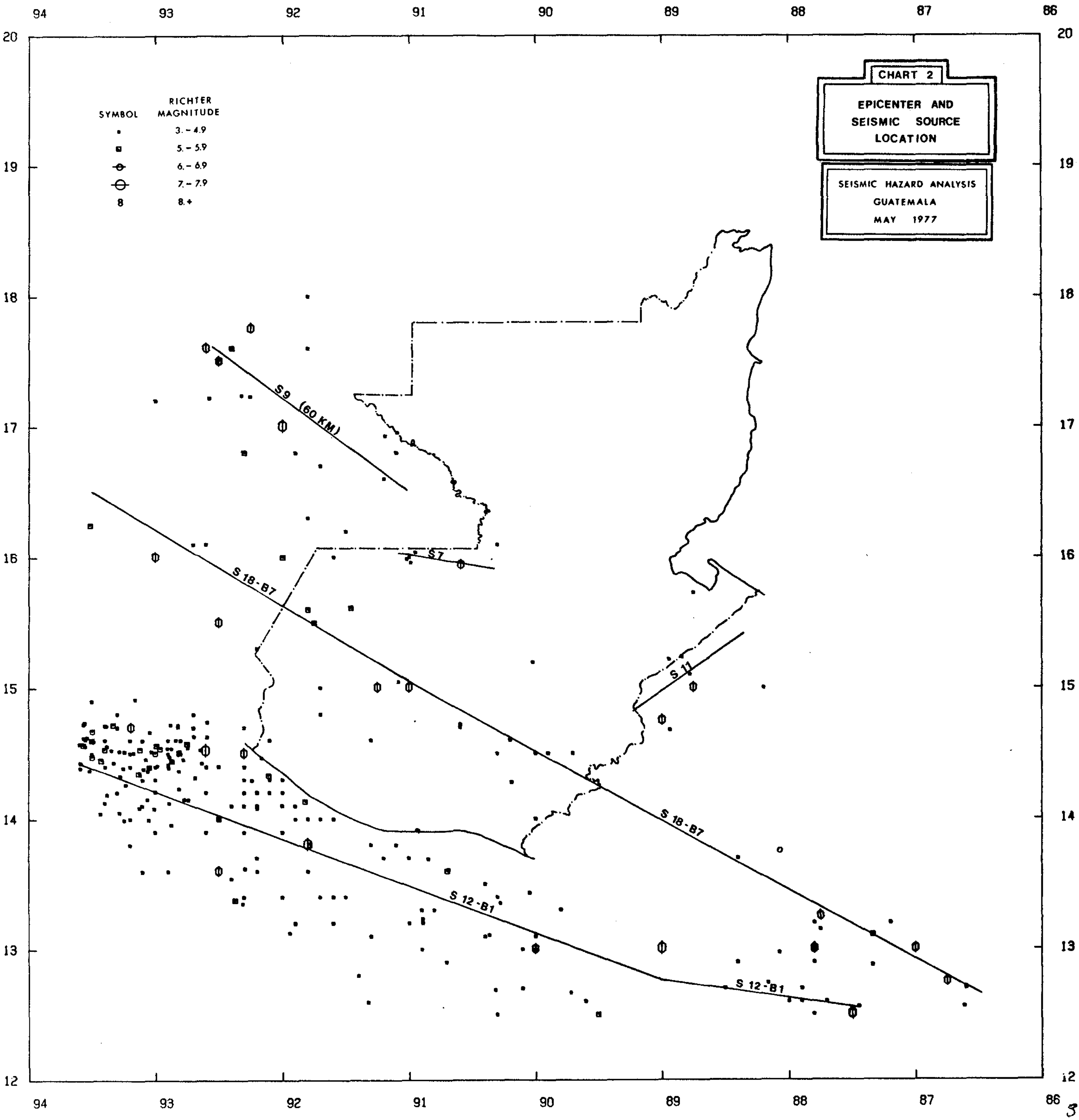

CHART 2

EPICENTER AND SEISMIC SOURCE LOCATION

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

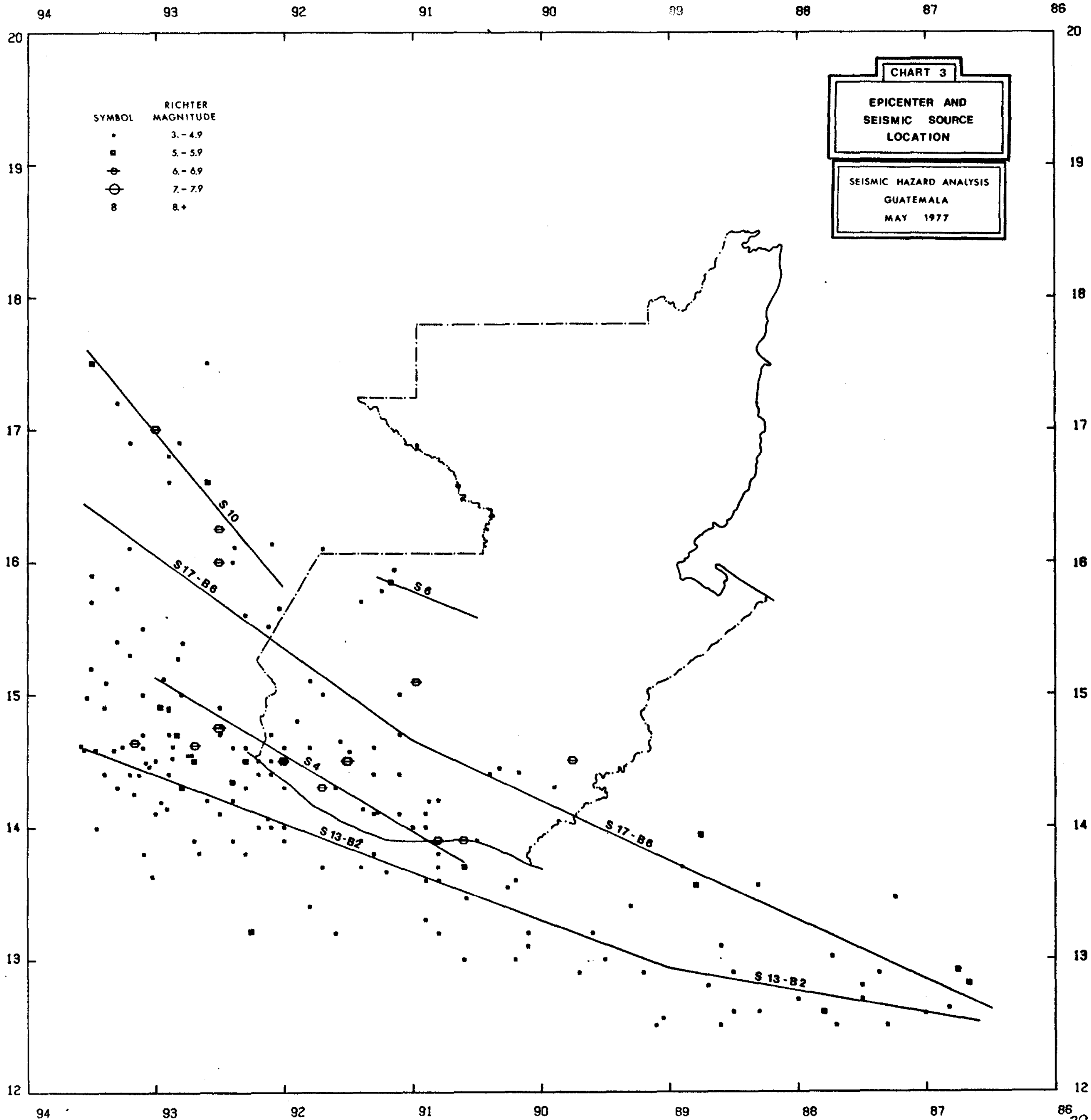

CHART 3

EPICENTER AND SEISMIC SOURCE LOCATION

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

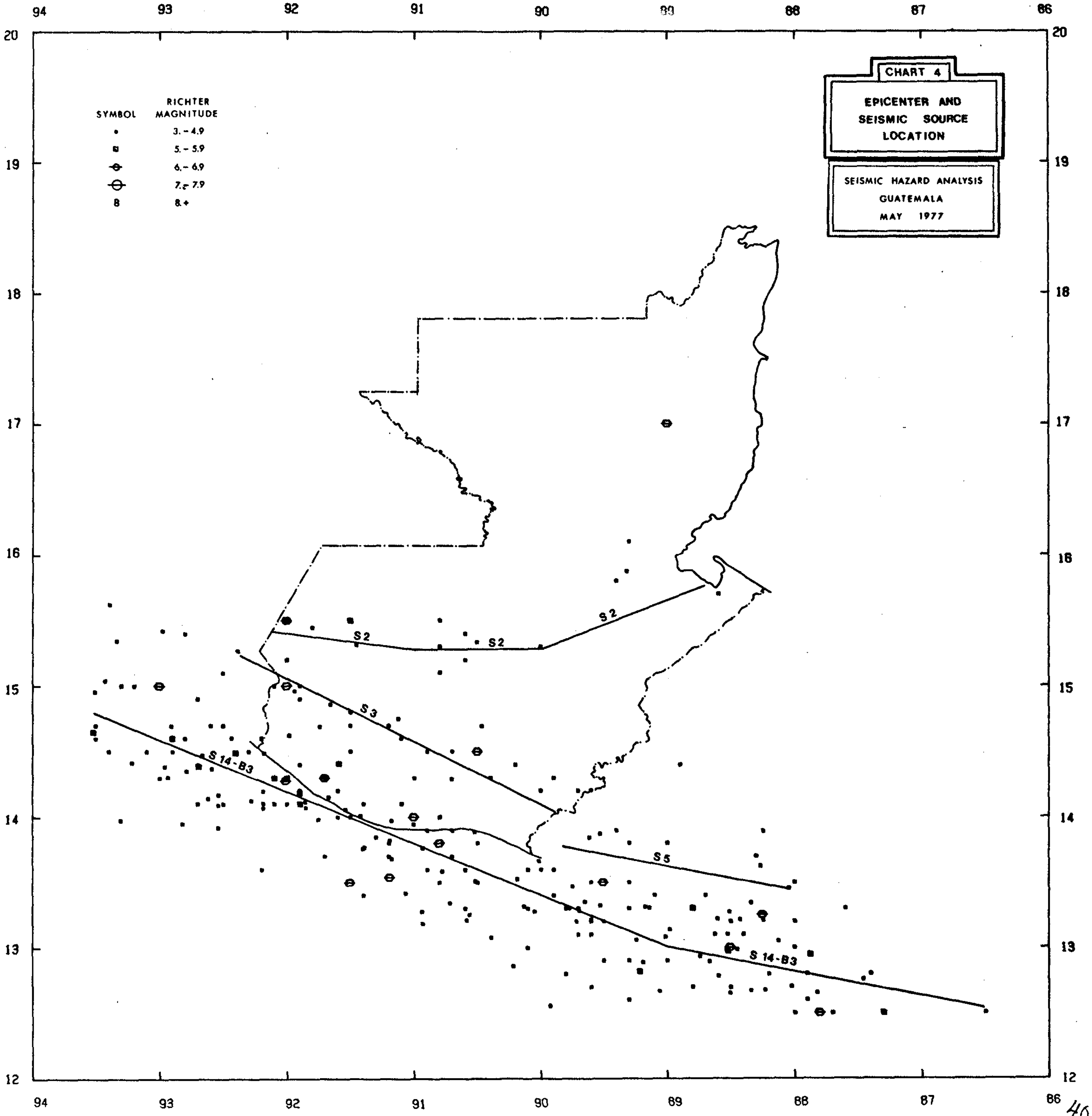

CHART 4

EPICENTER AND SEISMIC SOURCE LOCATION

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

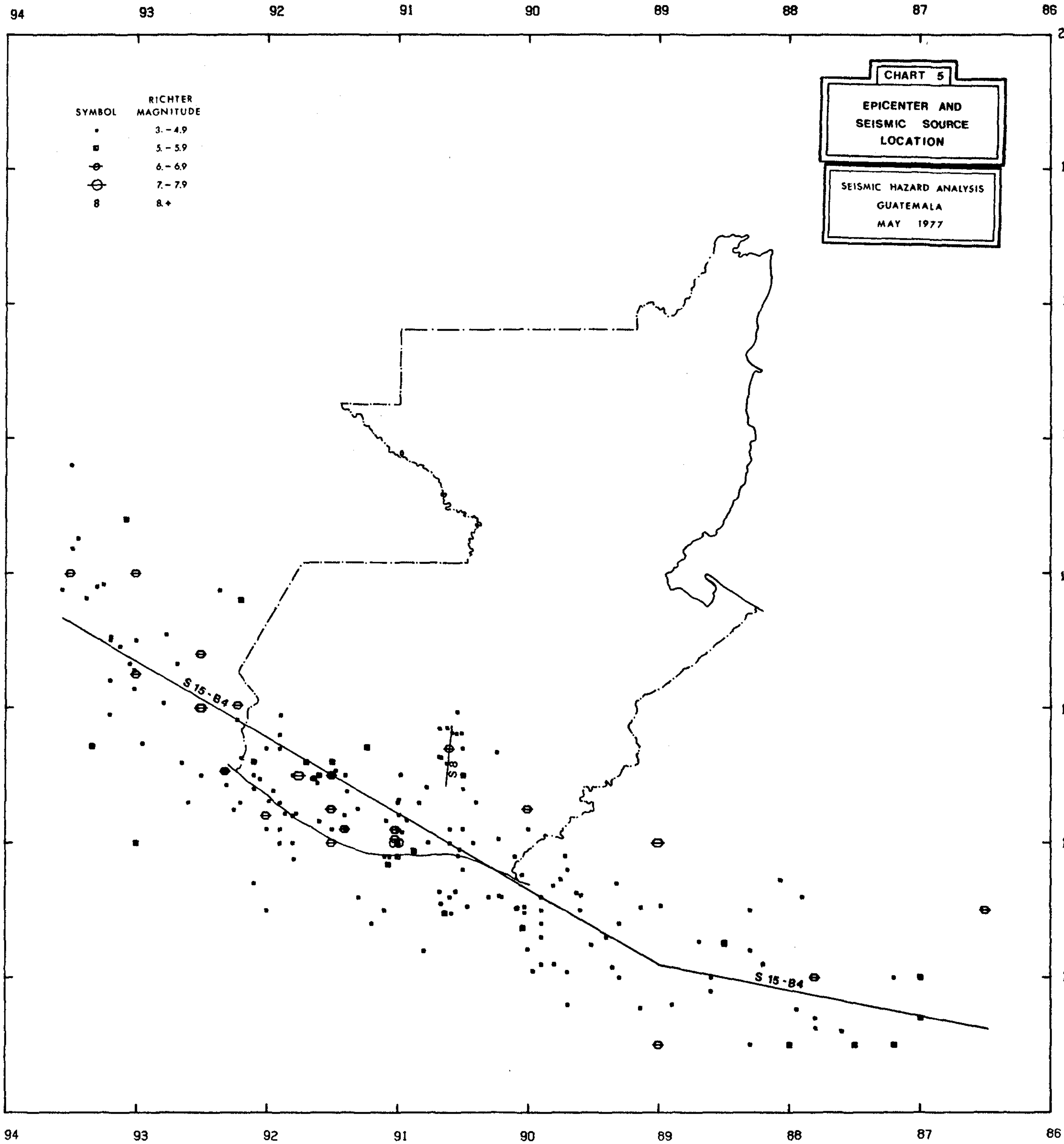

CHART 5

EPICENTER AND
SEISMIC SOURCE
LOCATION

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977

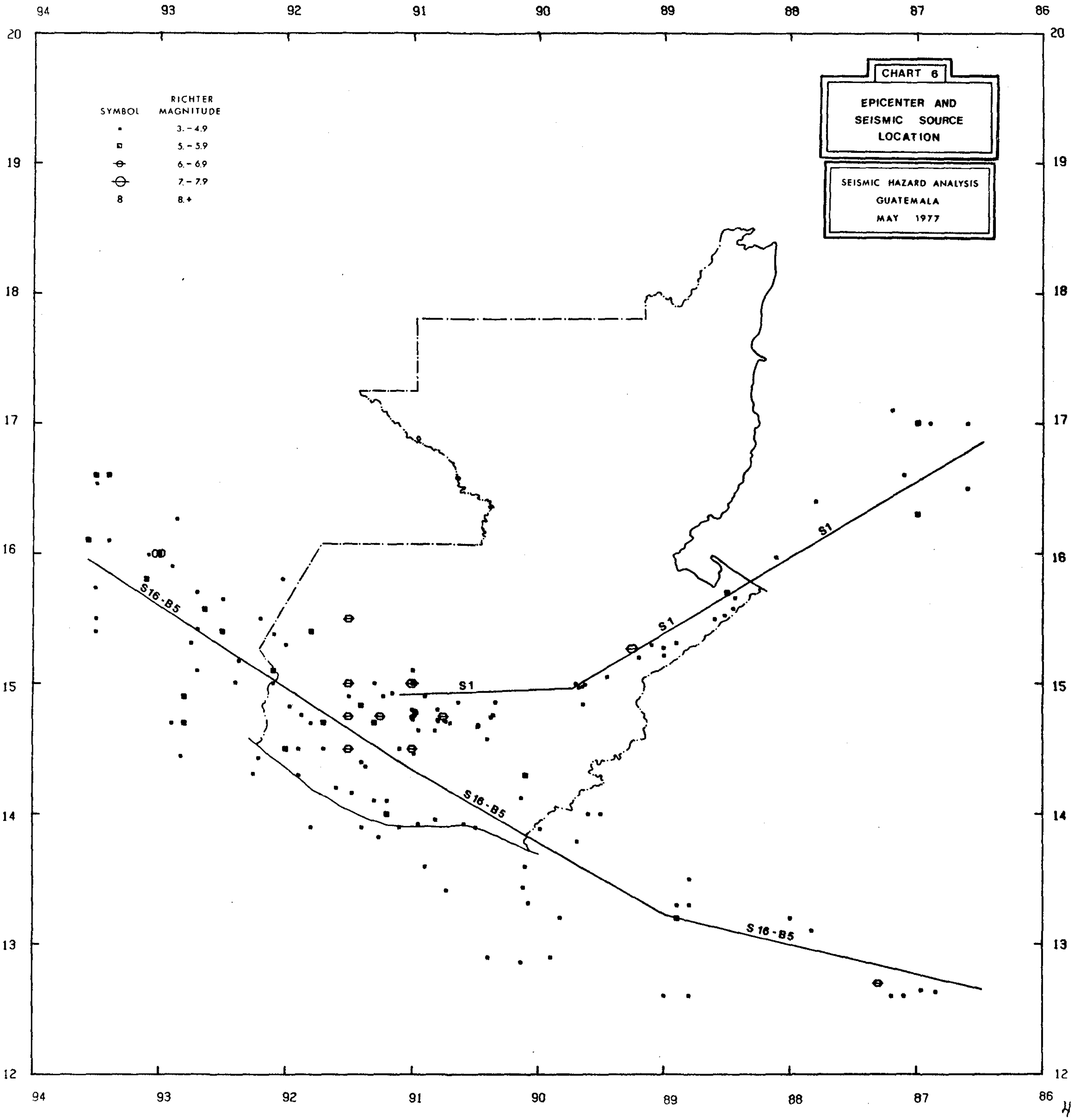

CHART 6

EPICENTER AND SEISMIC SOURCE LOCATION

SEISMIC HAZARD ANALYSIS
GUATEMALA
MAY 1977