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Western Puerto Rico Seismicity

By

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ABSTRACT

The distribution of 268 small earthquakes recorded during a 1-year period in the western part of Puerto Rico indicates that deformation is occurring along well defined surface or near-surface geologic structures. The distribution of hypocenters ranges in depth from near surface to a maximum depth of about 30 km, although a diffuse south-dipping seismic zone beneath Puerto Rico extends up to a maximum depth of 155 km.

Focal mechanism solutions suggest that the Puerto Rico block itself is deforming in response to active northeast-southwest directed horizontal compressional stresses with an apparent NNE-SSW rotation to the south.

The island of Puerto Rico seems to behave like a small microplate caught in a wide transform margin between the North American and Caribbean plates. The margins involve westerly trending, strike-slip faulting along the Muertos Trough and Puerto Rico Trench.

Magnitudes were determined using the signal duration method, and a <u>b</u> value of approximately .74 was determined for earthquakes within the western Puerto Rico region.

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INTRODUCTION

During late 1975, the first steps were taken to establish a permanent telemetered seismic network in Puerto Rico. The aim of this project was the rapid assessment of regional and local seismicity and secondly the estimation of the associated seismic hazard for the Puerto Rico Region (Tarr and King, 1976).

Puerto Rico lies within the northeastern boundary of the Caribbean plate. This boundary is marked by the frequent occurrence of both shallow and intermediate focus earthquakes (Sykes and Ewing, 1965). Historically, large, destructive earthquakes have also occurred in this region (Campbell, 1972).

The major problem in assessing seismic risk for any region or specific site is to determine, with some degree of confidence, the necessary data for the seismic risk analysis. Three categories of data are needed for the analysis:

a. potential earthquake sources;

b. the recurrence rate of events at each source; and

c. the attenuation of seismic waves by the media in the region or around the site.

The study of the historical earthquakes for any region is the first source of information to identify potential earthquake sources. However, some times the historical earthquake catalog is not complete and further facts are needed to identify the sources. Detailed field geological mapping provides the additional information that is desired, but, is very expensive and time consuming. An alternative is the use of geophysics to identify and delineate the major potential sources.

In Puerto Rico, field geologic mapping has been done mostly by the U.S. Geological Survey. Many geophysical investigations have been carried out for better understanding of the geology and identification of major structures. Gravity measurements on the island have been reported by Shurbet and Ewing (1956). Large, negative gravity (free-air) anomalies were first discovered over the Puerto Rico Trench in 1926 by Vening-Meinesz. Many refraction and gravity lines have been obtained from the Puerto Rico Trench region. Excellent summaries of the results have been presented by Talwani, et al. (1959), Bunce and Fahlquist (1962), and Bowin (1972). Results of magnetic surveys are presented by Griscom and Geddes (1966) and PRWRA (1974). The general offshore structure was mapped around much of the island by seismic reflection techniques. Structurally, the offshore section is a reasonable extension of the geology mapped onshore (PRWRA, 1974). Continuous seismic reflection profiles have also been recorded across the Muertos Trough, Puerto Rico Trench, and outer ridge.

The principal objective of this study is to understand the relationship between the microseismicity in Puerto Rico and surface or near-surface geologic structures. A secondary objective is to determine the magnitude-frequency relationships for different regions. The area of study (figure 1) is bounded between latitude $17.5^{o}N$ - $19.0^{o}N$ and longitude $66.5^{0}W$ - $68.0^{o}W$. An index map for detail location of major structures is shown in Figure 2.

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44. Vening Meinesz, F. A., Umbgrine, J. H. F., and Kuenen, Ph. H., 1934, Gravity expedition at sea 1923-1932: N. V. Tech. Boekhandel en Brukkerij, J. Wattman Jr. Delft, V. II, 208 p.

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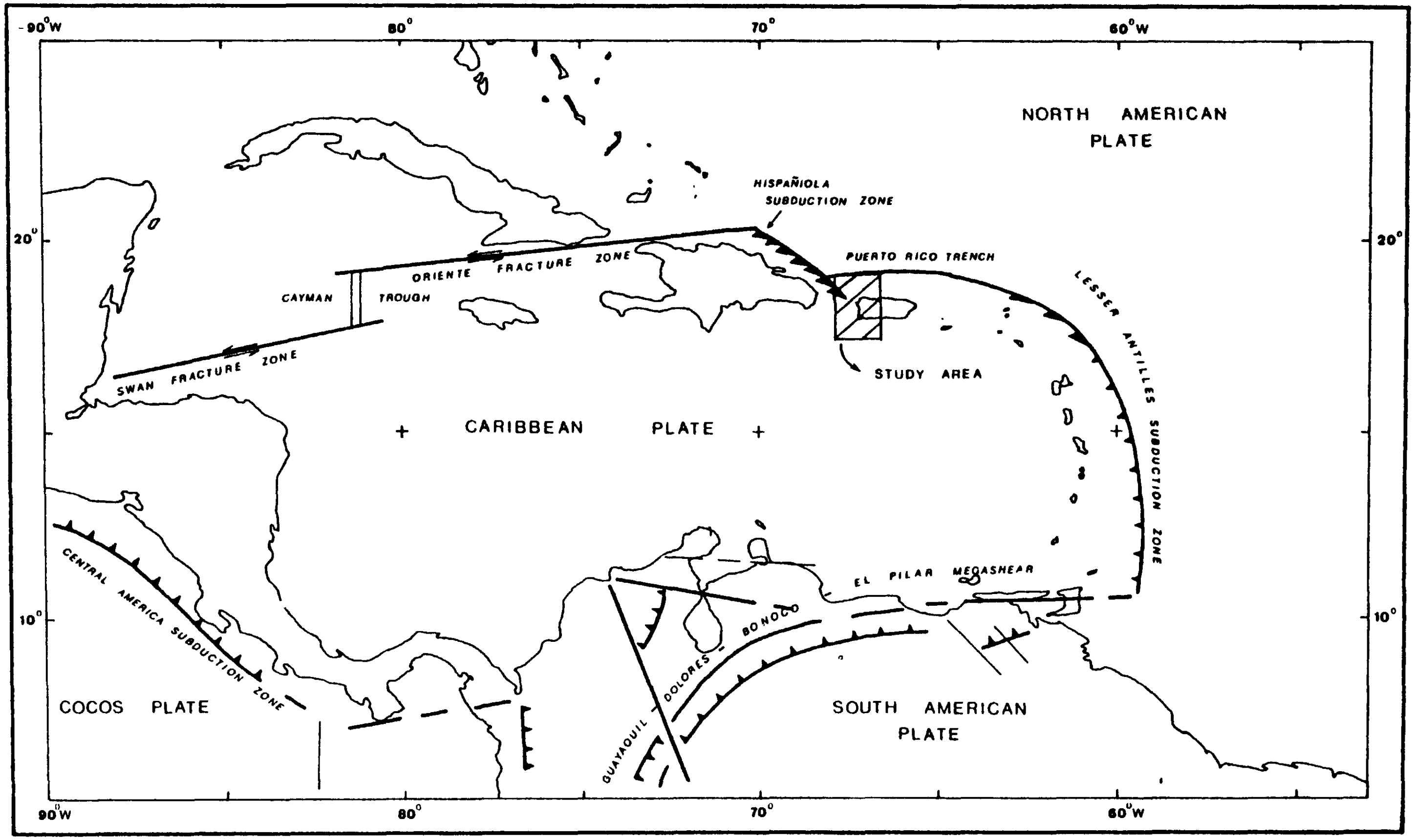


Figure 1: Location map showing area of study (cross-hatching) and major tectonic features. Regional tectonics modified after Schell and Tarr, (1978).

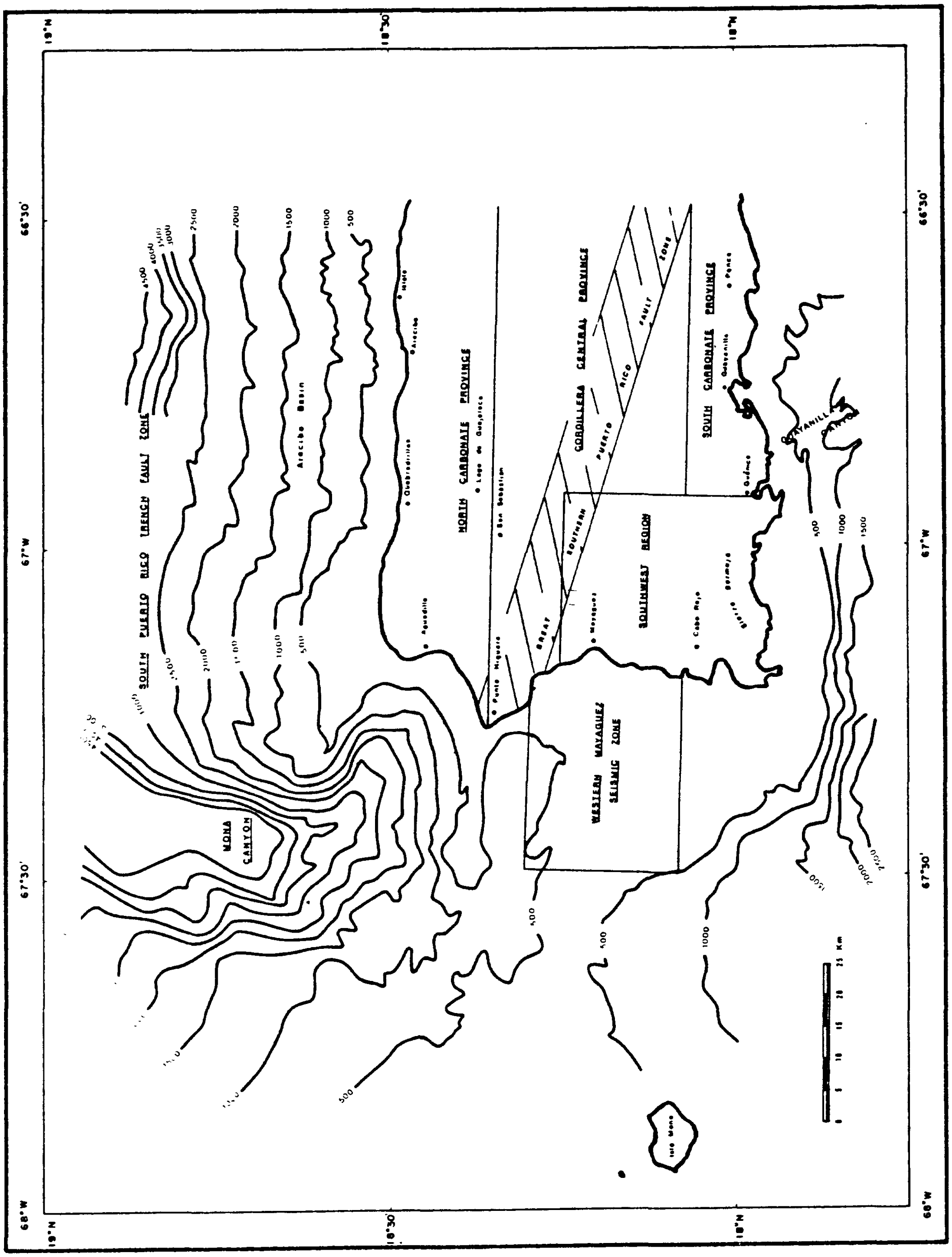


Figure 2: Western Puerto Rico Region Location map showing major physiographic and geological provinces. Iscbath contours in fathoms.

PUERTO RICO GEOLOGY

A. Summary

Through Late Cretaceous and early Tertiary time large masses of volcanic material were deposited adjacent to and contemporaneously with thick limestone sequences in the Puerto Rico portion of the Caribbean Island Arc (Almy, 1969).

The oldest rocks in the island are serpentine, chert, amphibolites, submarine basalts, and pyroclastic rocks, exposed in the central and south-western portion of the island. Thick carbonate sequences were deposited on the north and south coast gently dipping seaward. These rocks are almost entirely marine, mostly limestone, and range in age from Oligocene to Miocene (figure 3).

The older complex is intruded by rocks ranging in composition from peridotites (serpentine) to granite. Structural deformation, Late Cretaceous - early Tertiary, formed a central anticlinorium which trends west north-west to west and has been intensely faulted.

Four major fault systems have been identified that are considered to control the present structural deformation of the western portion of Puerto Rico (figure 4).

1. The Great Southern Puerto Rico Fault Zone extends diagonally across the island, trending offshore, to the west, toward Isla Desecheo. The total length of the fault including its offshore segments, is approximately 112 km, and

its displacement is predominantly left - lateral.

2. Puerto Rico Trench - is an east-west trending deep linear topographic depression, with predominantly high-angle faults trending in the same direction.
3. Mona Canyon - two major fault systems, East and West Mona Canyon Fault Zones, along the Canyon wall have been identified. The western portion of the fault system extends southeast across the head of the canyon and to the west of the Isla Desecheo where it intersects and appears to truncate the Great Southern Puerto Rico Fault Zone.
4. Muertos Trough - is an elongate east-west depression south of Puerto Rico. Several structural features mapped within the north margin of the trough have been considered to be characteristic of active island arc margins. (Ladd and Watkins, 1978, 1979; Garrison et al., 1972; Matthews and Holcombe, 1976).

A detailed description of the Puerto Rico geology follows. It is up to the personal interest of the reader to continue or skip to the next section, Regional Seismicity and Tectonics.

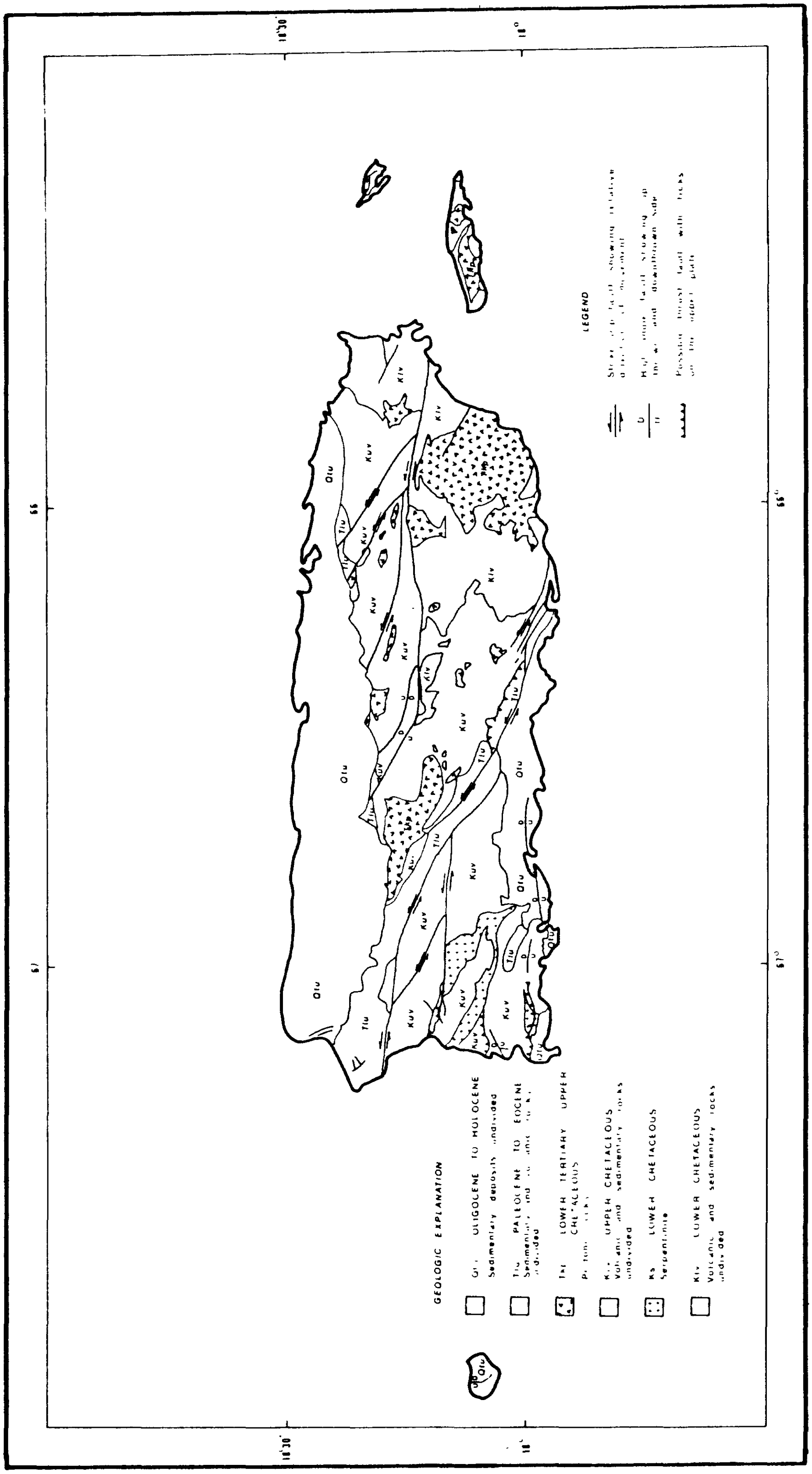


Figure 3: Generalized geological map of Puerto Rico (modified from Cox and Briggs, 1973).

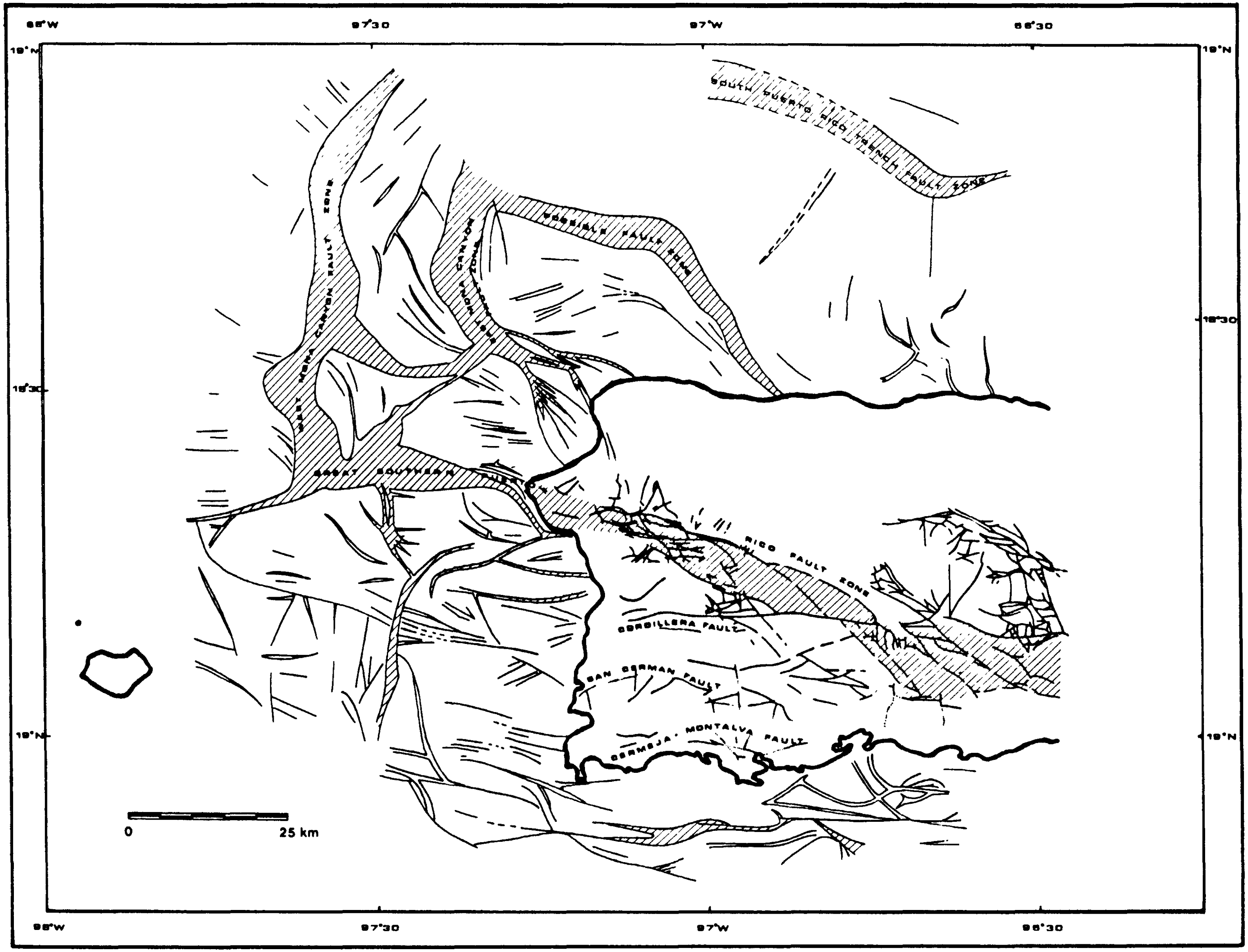


Figure 4: Western Puerto Rico structural features and major fault zones (shaded area).

B. General

The island of Puerto Rico can be divided into three major geologic provinces: The Cordillera Central Province, the Carbonate Province, and the Coastal Lowlands Province.

The oldest rocks in the island are in the basal or Bermeja Complex of the Cordillera Central Province (Mattson, 1960). They include silicified volcanic rock, spelites, amphibolites, and serpentinized peridotite. A broad, folded sequence of sedimentary and volcanic rock of Cenomanian or Santonian to Paleocene or possibly Eocene age conformably overlays the complex (Krushensky, 1978).

The oldest volcanic rocks occur as submarine basalt flows and pyroclastic rocks. Throughout the island, the volcanic rocks show a general upward change in the section from basaltic to andesitic, from submarine flows to nonmarine pyroclastic, and from the alkaline to the calc-alkaline family.

The older complex is intruded by rocks ranging in composition from peridotite (serpentine) to granite (Kaye, 1957). The larger plutonic bodies, much as those in the northeastern corner (San Lorenzo batholith), and central part of Puerto Rico (Utuado pluton) are composite complexes containing rocks that range in composition from gabbro to granite. Geophysical studies conducted by Western Geophysical (PRWRA-PSAR-NORCD-NP-1, Section 25, 1974) suggest the plutonic region extends to the northwest under the Carbonate Province off the northwest coast.

Structural deformation was most active in the latest Cretaceous and early Tertiary times. Deformation formed a central anticlinorium which trends west-northwest to west and has been intensely faulted. Major faults display vertical dip, trend westerly, and show significant strike-slip or vertical movement. Although some of these faults individually show right-lateral movement, net strike-slip is significantly left-lateral for any large area and for the island as a whole.

The two major zones of deformation are identified as the Great Southern Puerto Rico Fault Zone (figure 4) and the Great Northern Puerto Rico Fault Zone.

The Great Southern Puerto Rico Fault Zone extends from Central Aquirre on the south coast diagonally across the island to the west coast near Punta Higuero. The total length of the fault, including the offshore segment, is approximately 112 km.

The Great Northern Puerto Rico Fault Zone extends from near Punta Lima on the eastern coast of the island and passes under the well-stratified, unfaulted mid-Tertiary sequence of the northern Carbonate Province (Garrison, et al., 1972; Cox and Briggs, 1973).

The Carbonate Province is of middle Tertiary age. The rocks are almost entirely marine, mostly limestone and range in age from Oligocene to Miocene, possibly to Pliocene (Bermudes and Sieglie, 1969).

In northern Puerto Rico, the carbonate outcrop strikes east-west and dips 4 to 6 degrees to the north. It extends from the eastern end of San Juan to the westernmost tip of the island. The belt is narrow at the extremities, but it widens to a maximum of about 26 km near Arecibo (Monroe, 1973). The maximum total thickness of the north coast carbonate is 5,580 feet (1,701 m) on the island (Briggs, 1961). Offshore in the Arecibo Basin, the strata thicken , and seismic profiles show over 11,000 feet (3353 m.) of strata above the acoustic basement (PRWRA, 1974).

Carbonates in southern Puerto Rico are mid-Oligocene to Miocene in age and characteristically dip 12 to 20 degrees to the south. Two divisions based on lithology have been made: Juana Diaz Formation and Ponce Limestone (Monroe, 1973; Moussa and Sieglie, 1970). Structurally, the southern part of the island is more complicated than the northern part.

The Coastal Lowlands Province is characterized by swamps, marshes, fluvial plains, and lagoons. In the northern part, it extends from Arecibo to the eastern edge of the island. Tertiary and Quarternary limestone remain only as isolated knobs of relatively low relief. In the south, between Ponce and Guayama the plain is characterized by piedmont alluvial fans. Coastal mangrove swamps and marshes and beach ridges commonly occur along the south coast. The most extensive Quaternary deposits of the southwest coast occur in and around Valle de Lajas.

1. Structural Characteristics of Western Puerto Rico - Onshore

Late Cretaceous and Eocene deformation in western Puerto Rico consists of northwesterly trending open folds cut by westerly trending strike-slip faults (Almy, 1969).

The major feature in the area is the Great Southern Puerto Rico Fault Zone. It extends from Central Aguirre on the south coast diagonally across the island to the west coast near Punta Higuero. At Punta Higuero, the fault zone trends offshore toward Isla Desecheo (PRWRA, 1974). The total length of the fault, including its offshore segments, is approximately 112 km.

In the western portion of Puerto Rico, the fault zone is fairly continuous, and displacement is predominantly left-lateral. South of Utuado batholith, the fault zone is represented by numerous short, normally faulted segments. Most of the faults within the zone trend northwest-southeast, but the zone also has present northeast-southwest trending faults.

Locally, fault and fold patterns follow that of the main structures. In the southwest part of the island, all faults are near vertical and generally show dip-slip movement. The major trend strikes westerly, and a secondary trend developed near Ensenada strikes north-northwest to north-northeast (Almy, 1969).

The most prominant faults in the southwestern area are the Montalva Fault, Bermeja Fault, Melones Fault, and a fault in the southern part of Ensenada. Mattson (1960) mapped and described two major faults in the Mayaguez-San German area:

the Cordillera and San German Faults. He suggests a left-lateral displacement along the faults. Mattson also suggests that the straight northern borders of the Valle de Guanajibo and Valle de Lajas are fault-controlled.

Structurally, the mid-Tertiary carbonate sequence in the southern part of the island is more complicated than in the northern part. At most places, the middle Tertiary strata are in fault contact with the older rocks of the central volcanic complex (Monroe, 1973; pg. 1096). Many of the faults extend from the middle Tertiary rocks into Cretaceous and lower Tertiary rocks. East of Guanica, the rocks are cut by many faults, and blocks of serpentinite, Cretaceous limestone, and volcanic tuff have been faulted upward against rocks as young as Miocene. West of the town of Ponce, limestone of the Juana Diaz Formation has been raised on the south against Ponce Limestone. The total displacement is not known but is probably about 200 m. Although many of the faults in and bordering the middle Tertiary strata of southern Puerto Rico trend north or east, no strongly preferred orientation is evident (Monroe, 1973; pg. 1096).

In the north, the mid-Tertiary carbonate sequence is basically undeformed. Off the north-central, faulting extending into the mid-Tertiary is confined to two systems: the south-bounding faults of the Puerto Rico Trench and near-shore faults. The carbonates are also terminated by faulting along Mona Canyon to the west and by an apparent facies change, probably to clastic sediments, to the east (PRWRA, 1974).

The south-bounding faults of the Puerto Rico Trench displace sea floor by several hundred meters and vertically offset subsurface reflective strata by more than 500 m.

The near-shore fault displaces rocks of the mid-Tertiary section and trends east-west but is not related to deeper faulting. It is considered a local discontinuous break caused by differential compaction and adjustment of strata and by regional tilting (PRWRA, 1974).

There is faulting also in the acoustic basement reflection throughout the offshore region. In the north central area, these faults generally trend northwesterly to north-south and may represent seaward extention of elements of the Great Northern Puerto Rico Fault Zone (PRWRA, 1974).

2. Offshore Structural Feature

The offshore structural geology of Puerto Rico was determined by Western Geophysical (PRWRA-PSAR-NORCO-NP-1, Section 25, 1974). The general structures offshore were mapped around the western part of the island by seismic reflection techniques. Major structural trends were identified using magnetic data.

The major offshore structure is the Puerto Rico Trench. It is an east-west trending, deep linear topographic depression which delineates the northeastern boundary of the Caribbean plate. Seismic refraction profiles oriented perpendicular to the trench axis indicated that the ridge bounding the trench on the north is characterized by a normal, three-layer oceanic crustal velocity structure. The velocity structure of the trench axis and the south wall of the trench differ from that of the northern side in that a four-layer structure is deduced and the total thickness is much greater (Officer, et al., 1959; Bunce and Fahlquist, 1962).

Geologically, Fox and Heezen (1975) recovered 24 dredge samples from the Puerto Rico Trench region. In all the samples from the south wall of the trench, carbonates were recovered. Fossils found in these samples indicate that they range in age from Late Cretaceous to early Miocene. Serpentinite was recovered in the deepest haul. Fox and Heezen suggested that this could reflect serpentinization along shear zone faults, or could reflect the tectonic implacement of hydrated ultramafic rocks (upper mantle or lower oceanic crust) along fault zones at the base of the south wall.

Mona Canyon is a major bathymetric feature off the northwest corner of the island that extends to the Puerto Rico Trench. It trends approximately north-south. Major structures may be postulated along the canyon based on topographic expressions alone.

Western Geophysical (PRWRA, 1974) identified two major fault systems along the canyon wall which they called the East and West Mona Canyon Fault Zones. On the east side, the north coast carbonate section is truncated abruptly at the top of the east wall. Toward the south into Bahia de Aguadilla, the bounding scrap and zone of stratigraphic discontinuity continue into shallow water. Several fault slivers can be traced southeastward toward the shore near Aguada and Aguadilla and are probably continuous with the faults mapped on land in the area (Cox and Briggs, 1973). A major discontinuity, the west offshore fault, extends from the west wall of Mona Canyon southeast across the head of the canyon and to the west of Isla Desecheo where it intersects and appears to truncate the Great Southern Puerto Rico Fault Zone.

Magnetic contours trend perpendicularly across the canyon. The steep magnetic anomaly gradient on the south side of the east-west trending magnetic low suggests the presence of a major lineament at depth. PRWRA (1974) suggests that this may represent one of the oldest tectonic lineaments on Puerto Rico reflecting structural boundaries that predate the formation of the Puerto Rico Trench, Mona Canyon, and the present configuration of the island. This east-west magnetic low trend is also shown on the aeromagnetic map and has been interpreted to be a thrust-fault boundary extending east of Puerto Rico (Griscom and Geddes, 1964).

The Great Southern Puerto Rico Fault Zone is traced directly west from Rincon on Punta Higuero to Isla Desecheo and beyond to its intersection and apparent termination against the west offshore fault.

South of the Great Southern Puerto Rico Fault Zone lies a broad basin with depth in excess of 900 m called the Bahia de Anasco Basin. The basin is floored with horizontal sediments increasing in northward dip deep in the seismic sections. Maximum thickness of the sediment fill probably exceeds 2,000 m. Three northward-tilted fault blocks with vertical displacements of 300 m to 700 m and a general east-west strike cut the basin. Some of the faults within the basin have topographic expression on the present sea floor for part of their length. The magnetic anomalies are generally complex, based on anomaly patterns. This region can be clearly segmented into two blocks (PRWRA, 1974). The high-frequency magnetic contours of the east block, in general, indicate shallow magnetic basement and faithfully reflect the seaward continuation of various basement rocks separated by east-west trending structural lines. The most prominent magnetic anomalies are caused by the known serpentinite dike. Magnetic anomalies in the structural block on the west are generally gentle and simple. One prominent anomaly at the west may be caused by elevated igneous basement rocks. The structure separating the east and west block seems to be a major tectonic break and appears correlatable with north-south discontinuities on the seismic reflection profile.

A minor bathymetric feature, the Guayanilla Canyon, occupies a 30 km indentation in the insular shelf off the south coast of Puerto Rico between Guanica and Ponce. The Guayanilla Canyon system is affected by four major canyons: Guanica, Guayanilla, Cuchara, and Muertos Canyons. The Canyon loses its valley characteristic at about latitude 17°35'N. Farther south is Muertos Trough at about 17°20'N. Small inflection in bathymetric contours as deep as 4,300 m indicate that Guayanilla Canyon may continue in some form to that depth (Trumbull, et al., 1973).

The elongate east-west depression which forms the northern margin of the Venezuela Basin south of Puerto Rico and the Dominican Republic is known as the Muertos Trough. It is 650 kilometers long and 45 kilometers wide (Matthews and Holcombe, 1967). The trough is floored with evenly layered turbidites gently dipping toward the north. Structural features mapped within the north slope of the Muertos Trough are considered to be characteristic of active margins elsewhere (Ladd and Watkins, 1979, 1978; Garrison, et al., 1972; Matthews and Holcombe, 1976). The inner slope structures identified on seismic reflection records are summarized herein after Ladd and Watkins (1978): 1) landward-dipping reflection horizons within the wedge of sediments underlying the slope suggest possible fault planes; 2) tectonically rotated sediment ponds, in which the deeper reflections dip more steeply landward than shallower reflectors, characterize the slope; 3) seismic refraction velocities are higher than would be expected from normal compaction due to the present overburden.

REGIONAL SEISMICITY AND TECTONICS

A. Regional Seismicity

General A compilation of all events recorded from 1824 to 1977 within the Puerto Rico region (latitude 17^{o}N to 21^{o}N and longitude 63^{o}W to 70^{o}W) appears in Appendix A. All the information was obtained from the Environmental Data Service (EDS) in Boulder, Colorado, and the National Earthquake Information Service (NEIS) of the U. S. Geological Survey in Golden, Colorado. Events from 1964 to 1977 and which are located using instrumentally derived data, are shown in Figure 5.

Historical Felt Earthquakes 1508-1972

A list of felt earthquakes on the island of Puerto Rico was compiled by Joel B. Campbell of Weston Geophysical Research in 1972. This investigation was part of the site study for the proposed Aquirre Nuclear Power Plant in the south part of the island.

A review of the earthquake history catalog of Puerto Rico, particularly for the western part of the island, was performed as part of this thesis (see Appendix B). The most destructive earthquakes on Puerto Rico are enumerated herein, Table 1, after Campbell (1972). The estimated intensity given for each earthquake is the maximum intensity (Modified Mercalli) reported on the island.

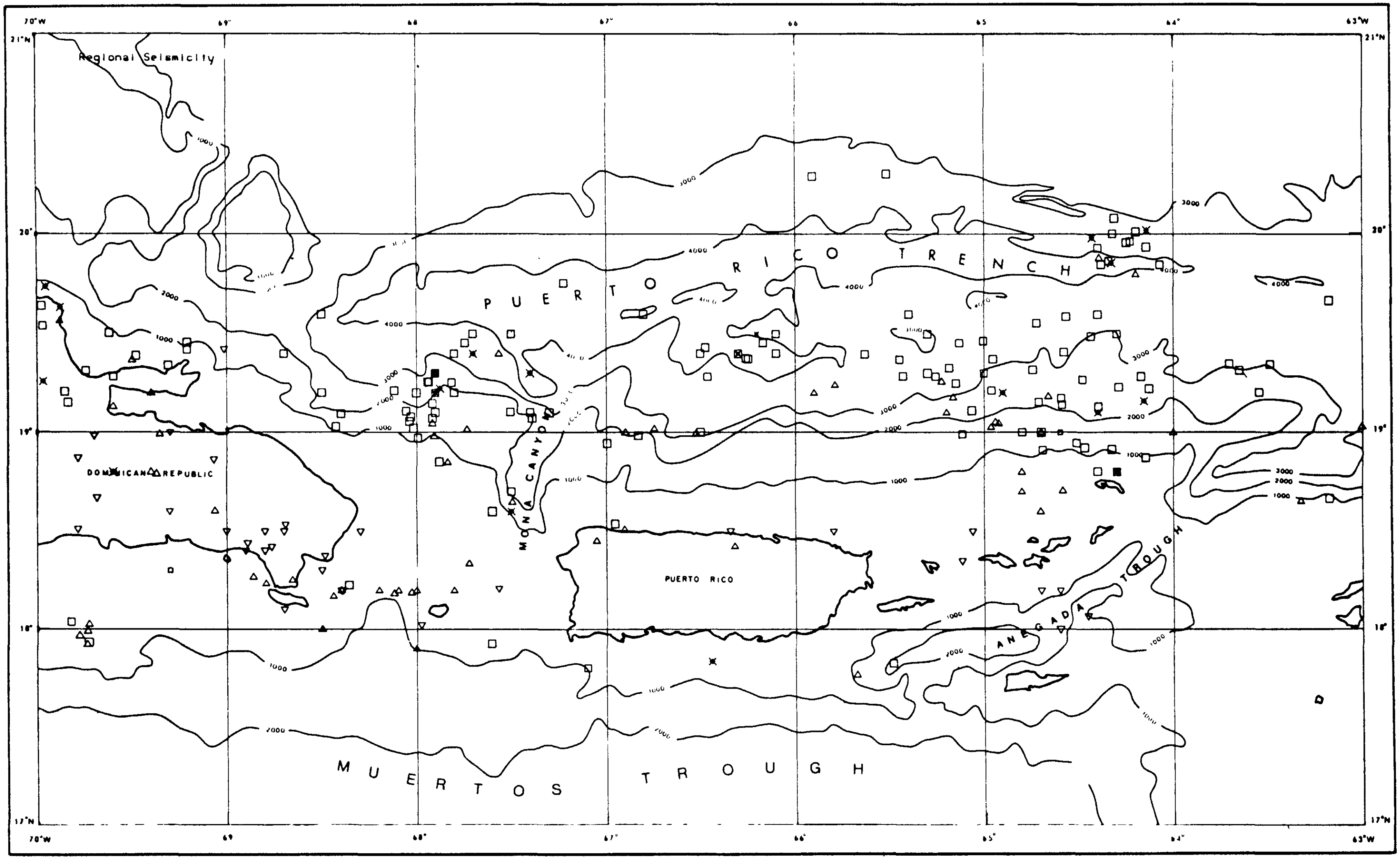


Figure 5: Puerto Rico Region Tectonic Zones and associated seismicity instrumentally recorded from 1964 to 1977. Symbols: ✱ denotes epicenter at depth < 25 km, □ depth > 25 and ≤ 50 km, Δ depth > 50 and ≤ 100 km, ∇ depth > 100 km. Contour interval, 1,000 fathoms.

TABLE 1

Most Destructive Earthquakes Felt on Puerto Rico

Date	Estimated Maximum Intensity (MM)	Description
1524-28	VI	(Date unknown.) A violent earthquake in western Puerto Rico which destroyed the home of Ponce de Leon and other buildings in Anasco. The shock was felt in Mayaguez and to the north.
1615 Sept. 08	VI	A strong earthquake in the Dominican Republic which caused damage and suffering in Puerto Rico.
1717	VII	(Date unknown.) Violent earthquake. Destroyed churches at Arecibo and San German.
1740 Aug. 30	VII	An earthquake destroyed the Guadalupe Church in Ponce.
1787 May 02	VIII	A violent earthquake over the entire island. Damage and destruction reported from all areas except the south.
1844 Apr. 16	VII	A severe earthquake. Various public buildings and homes were destroyed. Several churches were badly damaged.
1846 Nov. 28	VI	A strong earthquake. Felt throughout the island. Much damage on north coast.
1867 Nov. 18	VII-VIII	A disasterous earthquake and tsunami. Great damage, especially in the eastern part of the island.
1875 Dec. 08	VII-VIII	A strong earthquake. Damage at Arecibo and Ponce.
1906 Sept. 27	VI-VII	A strong double earthquake. Considerable damage reported from north coast.
1918 Oct. 11	IX	A disasterous earthquake and tsunami. Great damage on west coast. M=7.5
1946 Aug. 04	VI	A strong earthquake (Dominican Republic). Some damage on west coast of Puerto Rico. M=8.1
1946 Aug. 08	VI	Strong aftershock on August 8 with tsunami reported from Mayaguez and Aguadilla. M=7.6

B. Regional Tectonics

A continuous belt of shallow-focus seismicity defines the boundaries of the Caribbean plate. The Caribbean plate (see Figure 1) is bounded by the Cayman Trough on the north, by the Puerto Rico Trench on the northeast; by the Lesser Antilles Subduction Zone on the east; by South America on the south; and by the Central America Subduction Zone on the west.

Focal mechanisms have been used to determine the relative motion between the Caribbean and Americas plate (Molnar and Sykes, 1969). These studies indicate that the Americas plate is underthrusting beneath the Caribbean in a westerly direction, S 80^{o}W. The Caribbean plate boundary has a predominant left-lateral strike-slip motion along the northern boundary and right-lateral motion along the southern boundary.

The Puerto Rico Trench exhibits many features characteristic of island arcs, but there is not active volcanism, and focal mechanism solutions indicate motion almost parallel to the trench. The present model for the northeastern boundary suggests that a portion of the Atlantic lithosphere is sliding to the west past the Caribbean plate and under Puerto Rico without active subduction (Parsons and Molnar, 1976; Molnar, 1977). When this underriding plate reaches the Hispaniola Subduction Zone, it sinks deeper, taking on a plow-shaped configuration (Schell and Tarr, 1978).

C. Puerto Rico Region Seismo-Tectonic Zones

The distribution of earthquakes in the Puerto Rico region can be divided into several subregions or zones. These have been identified on the basis of their geologic characteristics as well as their seismicity. A brief description follows:

a. Puerto Rico Trench-- is seismically active along its south wall. Faults are predominatly high-angle, although, focal mechanism solutions suggest left-lateral strike-slip motion rather than underthrusting.

b. Muertos Trough--extends for about 650 miles parallel to the Greater Antilles ridge, south of Puerto Rico. The feature is a broad, gentle depression filled with turbidite dipping toward the north. The region is basically aseismic.

c. Eastern Hispaniola--the high level of seismic activity and its associated high-magnitude, deep focus events suggest underthrusting of the Americas plate. Focal mechanism solutions are consistent with this interpretation.

d. Anegada Trough--is the locus of a moderate number of events, some of them destructive (for example, November 18, 1867). The exact nature of faulting is not known.

e. Mona Canyon-Mona Passage--the Mona Canyon is bounded by fault zones that are seismically active. At least 40 events can be identified in the historical catalog as originating in the Mona Passage or northwest Puerto Rico. Of these events, several were destructive; others were only felt in the western part of the island. The Mona Passage is the locus of several large-magnitude, deep focus earthquakes. The most recent event in this region (23 March 1979, $m_b = 6.0$, $h = 80\ b_m$) was felt strongly throughout the Greater Antilles and moderately along the northern coast of Venezuela. No damage was reported.

f. Intermediate Zone of Seismicity under Puerto Rico--the combination of shallow events in the Puerto Rico Trench and intermediate-to-deep focus events under the island defines a seismic dipping zone under Puerto Rico. This zone is dipping about 55° to the south.

g. Shallow Puerto Rico Crustal Seismicity--in the historical earthquake catalog, Appendix B, at least 100 events have been reported locally in different regions of the island. For the western Puerto Rico region, three subregions of local felt events have been identified.

1. Northwestern and Central Puerto Rico - a total of 33 events have been identified in this area presumably most of them occurring at a depth greater than 50 km.

2. Mayaguez area - forty-eight events, occurring in the interval 1524-1958, have been reported as felt in this area. Some events were only felt in Mayaguez with an intensity of III - IV in the modified Mercali scale.

3. Southwest Puerto Rico - events reported as felt from Lajas to Ponce are included in this area. Twenty-five events were reported during 1740-1969.

The regional seismic-tectonic relationship for the Carribbean region is very well understood. However, there exists a general lack of understanding about the regional seismicity, geology and tectonics. The recent information gathered from the local seismographic network has made it possible to study this problem in detail and the results are presented in this thesis. Because of the large amount of data collected by the local network only the western part of Puerto Rico has been evaluated.

LOCAL SEISMICITY AND TECTONICS

Parameters and Location Procedure

Network Description

Station sites, during 1976, are shown in Figure 6 . Coordinates, elevation, date of installation, and magnification are given in Table 2 . Only vertical component seismometers (1 Hz natural period) are used at all sites except CDP and SJGC where the N-S, E-W components are also recorded. Each seismometer is buried 1 m within a concrete vault, usually placed over bedrock. The station signals are telemetered via microwave or radio links to the central recording location at the San Juan Geophysical Observatory at Cayey. The response of the seismometer and the telemetry system is flat within ± 30 db from 1 Hz to 30 Hz, which is appropriate for detection of high-frequency earthquake signal and tele seismic P-waves. Signals are recorded with the National Bureau of Standards and IRIG-E time codes on a 16 mm film (Develo corder, Teledyne Geotech, model RF-400).

Poisson's Ratio

Twelve earthquakes with four S readings were used to construct a Wadati diagram. There exist as linear relationship between the S-P time versus P arbitrary origin times. The best linear fit indicates a P to S velocity ratio of 1.779, or a Poisson's ratio of 0.27, (Figure 7)

TABLE 2

PUERTO RICO NETWORK STATIONS

Station	Location	Latitude N.	Longitude W.	Date of Operation (On-Off)	Magnification @ 5Hz	Elevation (m)
APR	Arecibo	18°27'27"	66°43'46"	11/14/75-	160 k	53
CDP	Cerro de Punta	18°10'30"	66°35'29"	07/30/75-	160 k	1,300
CDP-N		18°10'30"	66°35'29"	07/30/75-	80 k	1,300
CDP-E		18°10'30"	66°35'29"	07/30/75-	80 k	1,300
CPD	Cerro La Pandura	18°02'20"	65°54'55"	07/30/75-	320 k	370
CSB	Colonia Sabana	18°17'21"	66°09'21"	07/30/75-	320 k	430
EYP	El Yunque	18°18'43"	65°47'28"	07/30/75-08/09/76	80 k	1,060
IMR	Isla Mona	18°05'18"	67°50'50"	11/14/75-	160 k	55
IMR-N		18°05'18"	67°50'50"	11/14/75-02/20/76	35.2k	55
IMR-E		18°05'18"	67°50'50"	11/14/75-02/20/76	35.2k	55
LPR	La Peregrina	18°18'31"	65°52'10"	08/10/76-	---	580
LSP	Las Mesas	18°10'39"	67°05'10"	11/14/75-	160 k	390
MCP	Moca	18°25'08"	67°06'38"	11/14/75-	160 k	250
MGP	Maguayo	18°00'27"	67°05'21"	11/14/75-	640 k	60
PNP	Penuelas	18°03'30"	66°41'01"	07/30/75-	640 k	200
SJGC	Cayey	18°06'42"	66°09'00"	02/22/76-	640 k	457
SJGC-N		18°06'42"	66°09'00"	03/01/76-	320 k	457
SJGC-E		18°06'42"	66°09'00"	03/01/76	320 k	457
University of Puerto Rico Station						
MPR	Mayaguez	18°12'46"	67°08'21"			

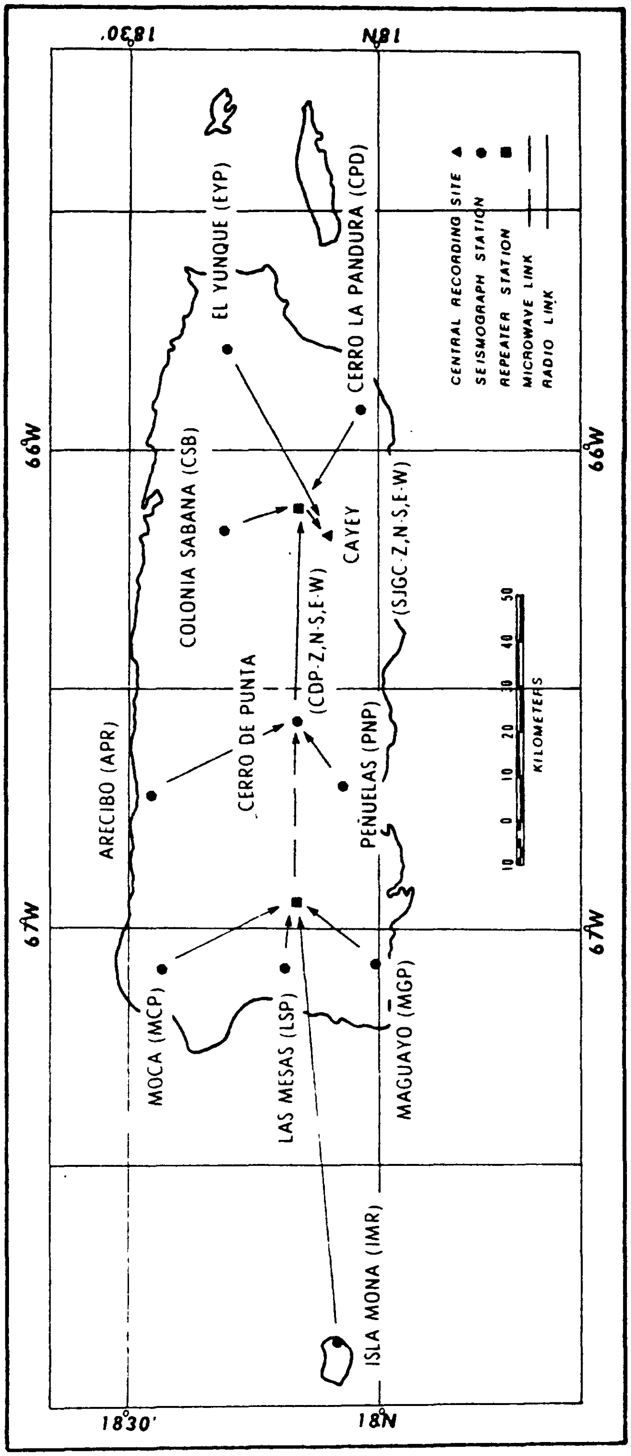


Figure 6: Puerto Rico Seismographic Network.

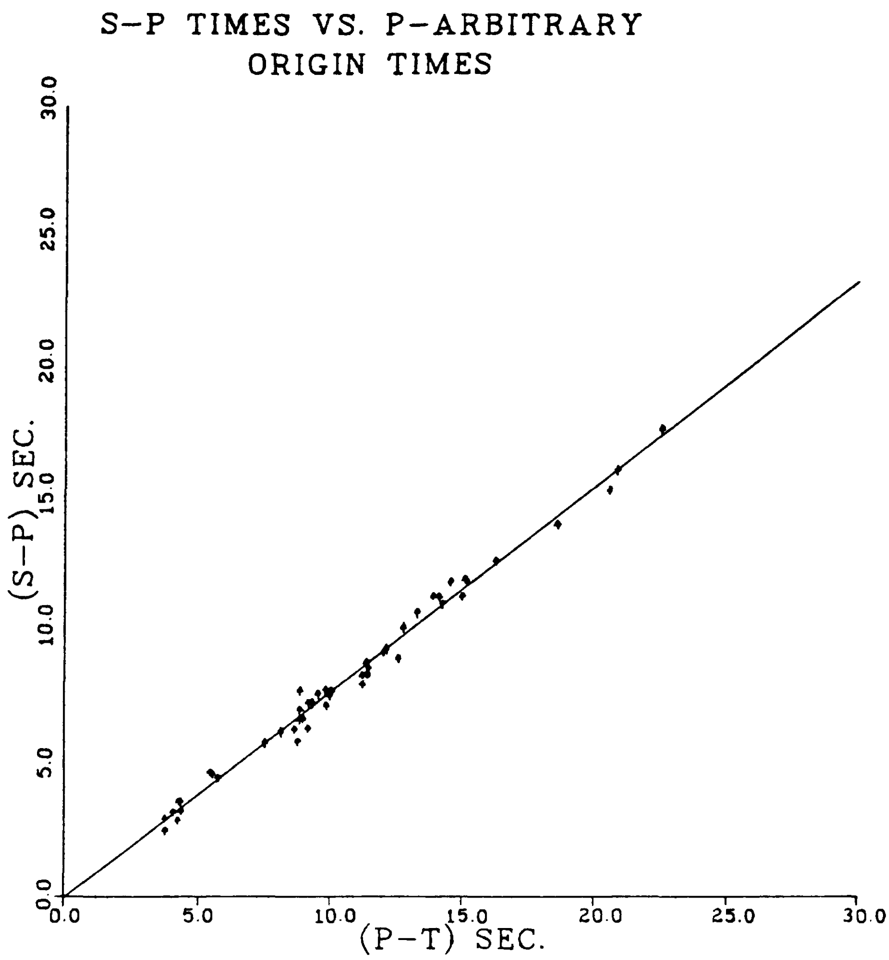


Figure 7: Wadati diagram - The velocity ratio of P and S waves in the upper earth's crust for the Western Puerto Rico region is 1.779 and the corresponding Poisson's Ratio is 0.27.

The purpose of studying the velocity ratio is in order to determine the focal depth and origin time in the hypocentral location procedure.

Crustal Structure

Three different investigations have been used for the determination of the crustal structure of Puerto Rico. The techniques include: 1) the study of refracted arrivals from earthquakes lying outside the array, 2) modeling the crustal structure using local events recorded withing the array, 3) seismic refraction and gravity data.

Each of the models determined using the methods mentioned above was used and tested in the earthquake location procedure. All three are very similar and had the capability to locate the events in the area of study fairly well.

A generalized model consisting of two layers (V_1 = 5.5 km/sec, h_1 = 8.8 km, V_2 = 7.0 km/sec, h_2 = 21.2 km) over a half - space velocity of 8.2 km/sec was chosen to represent the crustal structure of Puerto Rico. This model was determined by Talwani et al., (1959) using seismic refraction and gravity data. The other models derived from the study of refracted arrivals and inversion of travel times corroborate Talwani's model.

Method 1. Refracted arrival from earthquakes outside the island.

Table 3 lists the earthquakes recorded by the Puerto Rico Seismic Network used in this experiment, and Figure 8 shows their location. Three main sequences of events are used. These sequences correspond to major bathymetric features and possible fault zones. Figures 9 through 11 are graphs of first arrival times versus epicentral distance, showing linear least-squares fits to the raw data. Profiles are shown by the areas studied.

This study involves precise scaling of various impulsive compressional body wave phases from earthquakes outside the network. Three different impulsive phases were recognized and defined as follow:

P_1--First arrivals that are critically refracted at the top of the crystalline crust (P-wave velocity 6.43 ± .06 km/sec.). These correspond to the direct arrivals for earthquakes.

P_2--Arrivals that are critically refracted at the top of an intermediate layer in the crust (P-wave velocity 7.52 ± .20 km/sec.).

P_n--First arrivals that are critically refracted at the base of the crust (P-wave velocity 8.13 km/sec.).

The crust was assumed to consist of horizontal layers and its velocity to be nearly constant in each layer. Determination of dips was not possible because profiles are

TABLE 3

EVENTS USED IN CRUSTAL STUDY

Date	Origin	Latitude N. (Deg.)	Longitude W. (Deg.)	Depth (km)
75 11 18	19 12 28.10	17.7901	66.8909	14.94
75 11 23	21 40 52.36	17.7408	66.8804	00.14
75 11 30	14 05 17.33	17.8051	66.7740	08.38
75 11 30	16 05 09.09	17.7716	66.7438	02.28
76 01 08	06 30 34.81	17.9970	66.8885	08.85
76 03 05	01 12 48.32	17.7745	66.8128	06.07
76 03 14	22 43 52.28	17.9363	66.7930	01.59
76 03 28	20 32 49.29	17.9528	66.7701	15.42
76 03 31	02 38 46.72	17.7471	66.7838	01.47
76 04 01	16 45 28.22	17.8776	66.8652	13.53
76 04 13	23 10 09.34	17.9588	66.3881	19.21
76 04 20	14 01 26.70	17.8884	66.8886	24.81
76 05 14	04 20 10.55	19.0356	64.9986	15.92
76 05 14	05 57 16.07	19.1399	64.9775	11.99
76 05 14	23 18 57.35	19.2257	64.9186	16.24
76 05 14	23 22 41.95	19.2497	67.8497	49.00
76 05 15	00 09 53.00	19.0696	65.0131	19.65
76 05 15	00 22 00.24	19.2661	64.7560	27.99
76 05 15	04 27 57.29	19.1315	64.8462	02.38
76 05 15	06 58 48.60	18.9953	65.3404	01.98
76 05 15	07 19 11.06	19.0991	64.9931	12.70
76 05 15	09 09 08.48	19.0728	64.9177	12.05
76 05 15	09 15 24.59	19.0253	64.9626	09.97
76 05 15	13 21 42.70	19.1021	65.0536	09.14
76 05 15	14 31 07.82	19.0812	64.9785	11.09
76 05 15	22 19 44.32	19.0549	65.0688	12.86
76 05 16	02 27 54.23	19.2640	64.6355	15.00
76 05 16	03 52 37.07	19.0629	64.9220	15.00
76 05 16	05 13 07.83	19.1315	64.6740	15.51
76 05 25	21 34 47.85	17.7818	66.7999	13.06
76 05 26	05 19 50.44	17.7660	66.8160	07.65
76 05 29	03 07 53.93	17.7478	66.9241	00.73
76 06 01	03 15 06.37	17.8904	66.8172	10.22
76 06 01	03 56 07.09	18.0724	66.8505	27.02
76 06 01	11 44 16.71	17.7956	66.7885	03.68
76 06 13	21 39 11.44	19.1490	67.9818	09.30
76 06 14	01 03 49.20	19.0687	67.8794	13.97
76 06 14	02 32 42.98	18.9899	67.8656	15.19
76 06 14	03 51 19.40	19.0070	67.9112	18.65
76 06 14	04 37 10.85	18.9073	67.8545	29.02
76 06 14	04 43 00.53	19.0865	67.8411	14.04
76 06 14	05 21 49.12	19.2256	67.8252	19.59

TABLE 3 (cont.)

Date	Origin	Latitude N. (Deg.)	Longitude W. (Deg.)	Depth (km)
76 06 14	05 51 13.37	18.8239	67.7533	19.56
76 06 14	07 39 01.05	18.9456	67.8209	18.01
76 06 14	07 59 16.45	19.0891	67.8784	15.87
76 06 14	08 47 47.73	19.1390	68.0663	28.84
76 06 14	11 09 02.02	19.1605	67.9256	08.97
76 06 14	12 54 38.39	19.1061	67.8833	10.12
76 06 14	16 27 41.84	19.0914	67.9252	12.81
76 06 14	19 23 11.10	19.0320	68.1448	18.47
76 06 14	20 36 40.61	19.0679	67.9049	16.24
76 06 15	00 27 31.91	18.9806	67.7955	17.43
76 06 15	15 31 12.06	19.1785	68.0583	46.51
76 06 15	16 35 25.57	18.9499	67.9409	64.72

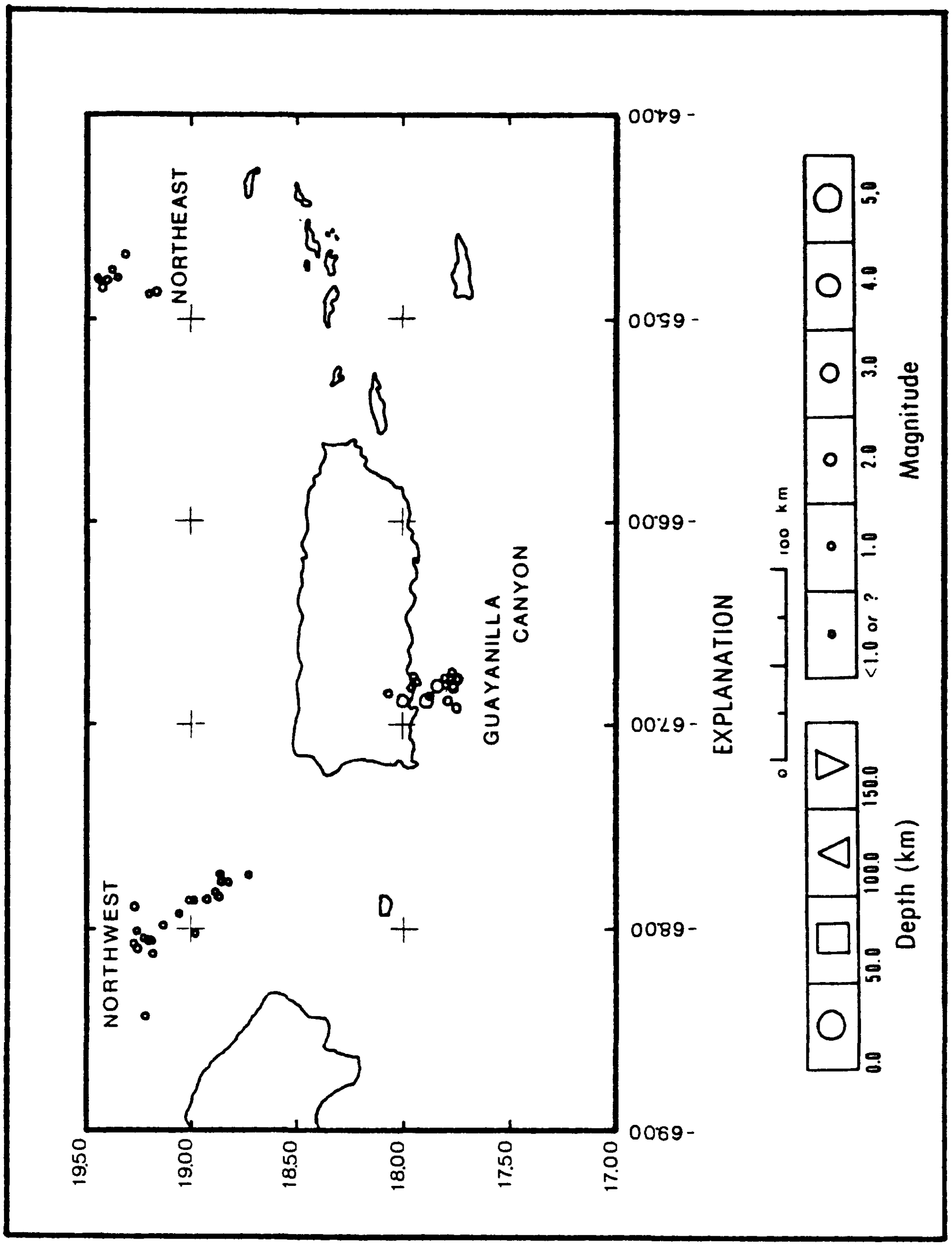


Figure 8: Local and regional seismicity used to study the crustal structure.

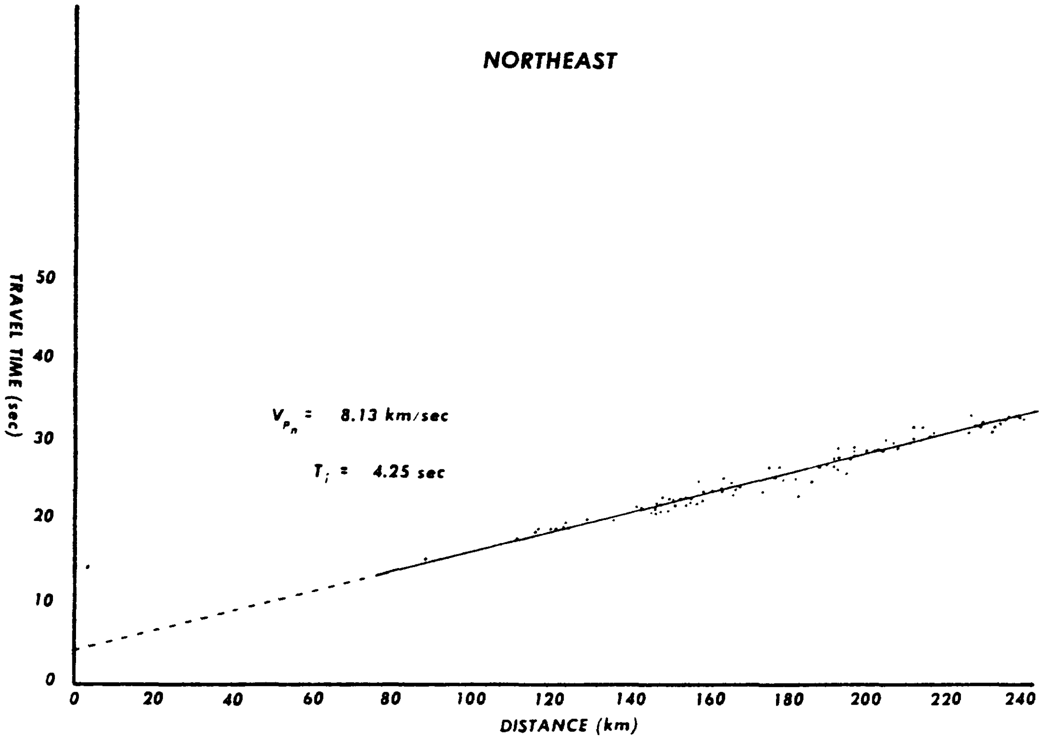


Figure 9: Travel time versus epicentral distance curve for earthquakes in the northeastern part of Puerto Rico.

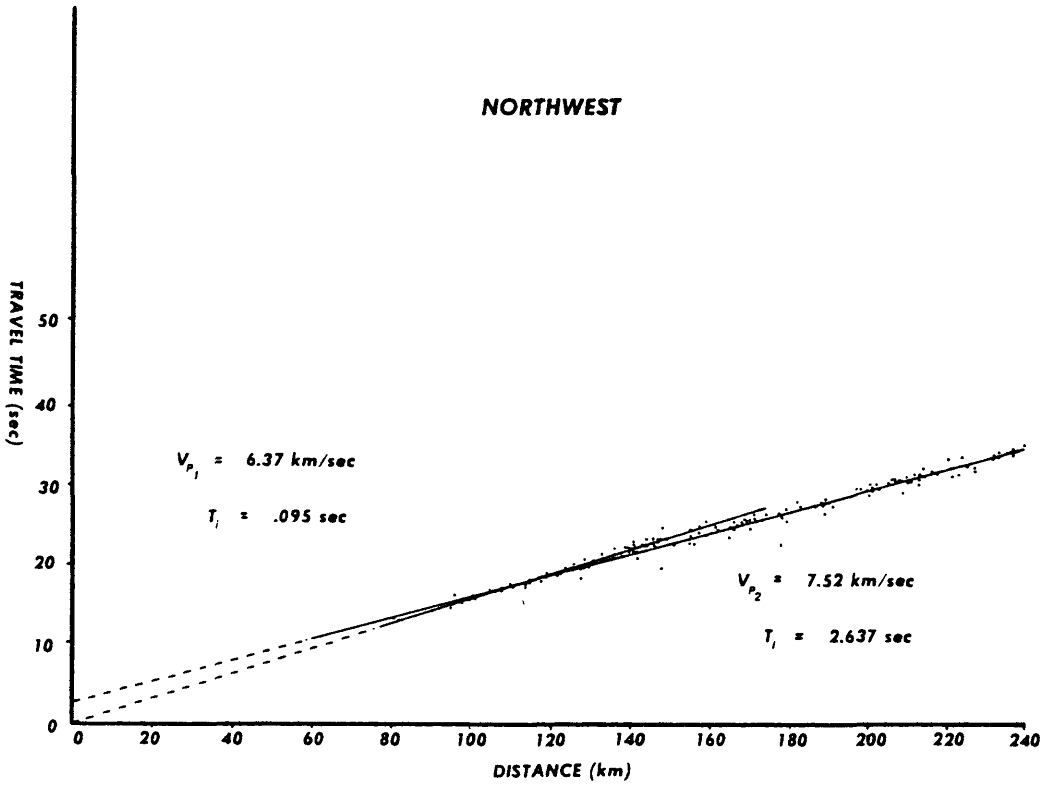


Figure 10: Travel time versus epicentral distances for earthquakes in the northwestern part of Puerto Rico.

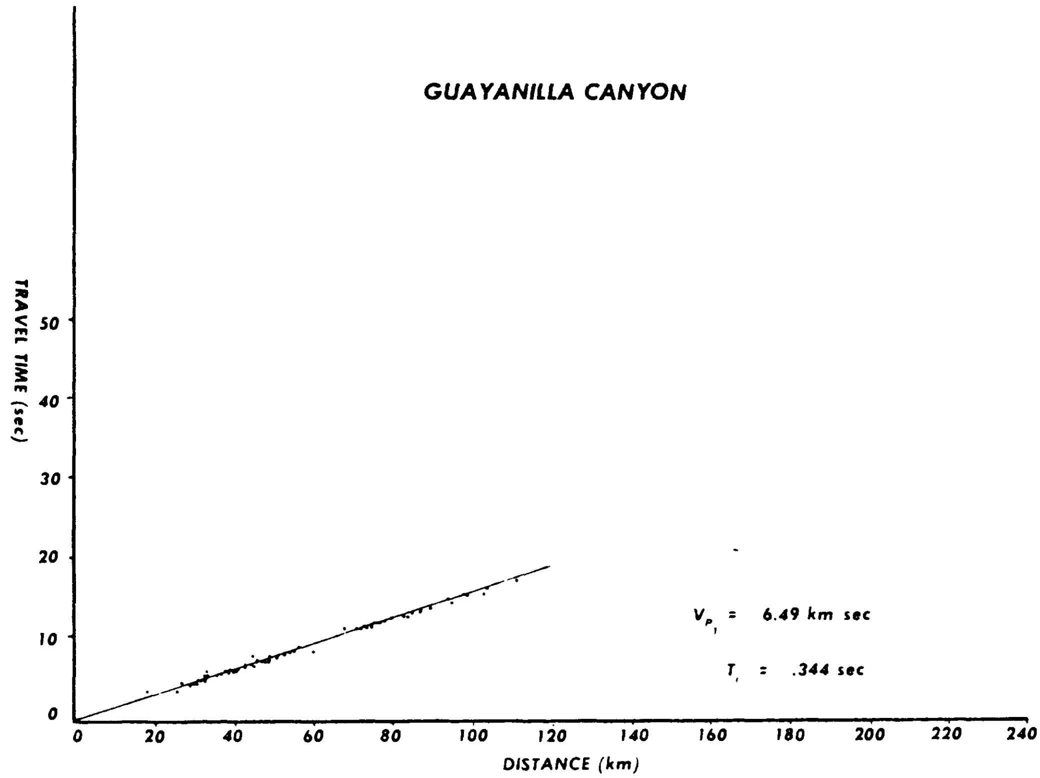


Figure 11: Travel time versus epicentral distances for earthquakes in the Guayanilla Canyon.

single ended. The P_1 velocity identified at two different locations close to the island shows an average velocity of 6.43 ± .06 km/sec.

A high velocity layer was identified in the northwestern part of the island. This high velocity layer of 7.52 ± .20 km/sec. was identified as a lower crustal layer by Officer, et al. (1959), and Edgar, et al. (1971), overlying a normal mantle velocity of about 8.1 km/sec. This high velocity layer was not very well defined at the northeast. The normal upper mantle velocity was not identified in the northwest part of the island.

A composite crustal structure was derived from the profiles. The model consists of two crustal layers over a half space as shown in Table 4.

TABLE 4

COMPOSITE CRUSTAL MODEL

Determined by scaling various body wave phases.

DEPTH TO LAYER BOTTOM (km)	LAYER P-VELOCITY (km/sec.)
15.79	6.37
27.37	7.52
∞	8.13

Method 2. <u>Crustal Structure Inversion of Local Array Data</u>

An independent experiment was conducted to determine the crustal structure of the Puerto Rico region. This method involves modeling the crustal structure using earthquake data. This approach was first described by Crosson and Peters (1970). Peters (1973) applied nonlinear least-squares inversion to the velocity hypocenter problem using a simple model and was successful in his approach. Crosson (1976) described a generalized least-squares estimation technique for extracting crustal structure information from a group of earthquake arrival times and had reasonable success even for models with low velocity zones.

The generalized inverse theory described by Crosson (1976) has been used by Bill Gawthrop of the USGS to develop a program to determine a basic velocity structure using different phase arrival times. This program is still in its experimental stage but has been tested successfully with data from networks in Alaska, California, Missouri, Nevada, and South Carolina where the earth's crust model was determined previously by other methods.

The program uses up to 50 stations from up to 12 seismic sources. It determines the source location parameters for each event and the velocity structure which best matches the input phase arrival times. The velocity structure used is a crust of linearly increasing velocity as a function of depth overlying a constant velocity mantle.

A flat earth approximation is assumed. A constant V_p/V_s (velocity) ratio is used for S-wave travel time calculations. This model was chosen because of the ease of calculation of ray travel time curves and the small number of parameters required to completely describe the model (Gawthrop, oral comm. 1979). A full description of the program is not included in this study since it eventually will be published by its author.

The seismic sources may represent the whole region or a particular area of study. In this experiment, the 12 events used represent the western part of Puerto Rico.

The main results of this program are the surface velocity, the velocity gradient, the depth to the mantle, the upper mantle velocity, the V_p/V_s ratio and the time residual. The model calculated by the inversion program is given in Table 5.

TABLE 5

MODELED CRUSTAL STRUCTURE

Surface Velocity	=	6.32 km/sec.
Velocity Gradient	=	0.041 km/sec.
Depth to mid-crustal interface	=	17.198 km.
Velocity of lower crust	=	7.27 km/sec
V_p/V_s	=	1.779 (fixed)

Method 3. Seismic Refraction and Gravity Data

The third approach was to use the model determined by Talwani, et al. (1959). The model for the Puerto Rico Region was determined using seismic refraction and gravity data. For the island of Puerto Rico itself, the model consists of two layers over a half space as shown in Figure 12. The depth of the mantle was calculated to be about 30 km from gravity data.

Location Procedure

The hypocenter program HYPO71 (Lee and Lahr, 1975) was used for the location of the Puerto Rico events.

Geiger's method is used in this program to determine earthquake hypocenter and origin times. This method, as summarized by Lee (1979), involves two basic concepts in mathematics: iterative solution of nonlinear equations, and least squares.

If an earthquake occurs at origin time t_o and at hypocenter location (x_o, y_o, z_o), what one observes in a microearthquake network is a set of arrival times (T_i) for stations located at (x_i, y_i, z_i), i = 1, 2, 3, ..., n. The real travel time $(T_i - t_o)$ from the hypocenter to the $_i$th station is, in general, a nonlinear function of the spatial coordinates. To linearize a nonlinear problem, one makes use of Taylor's series expansion.

The problem of determining hypocenters and origin time is a problem in a four dimensional space. The three spatial

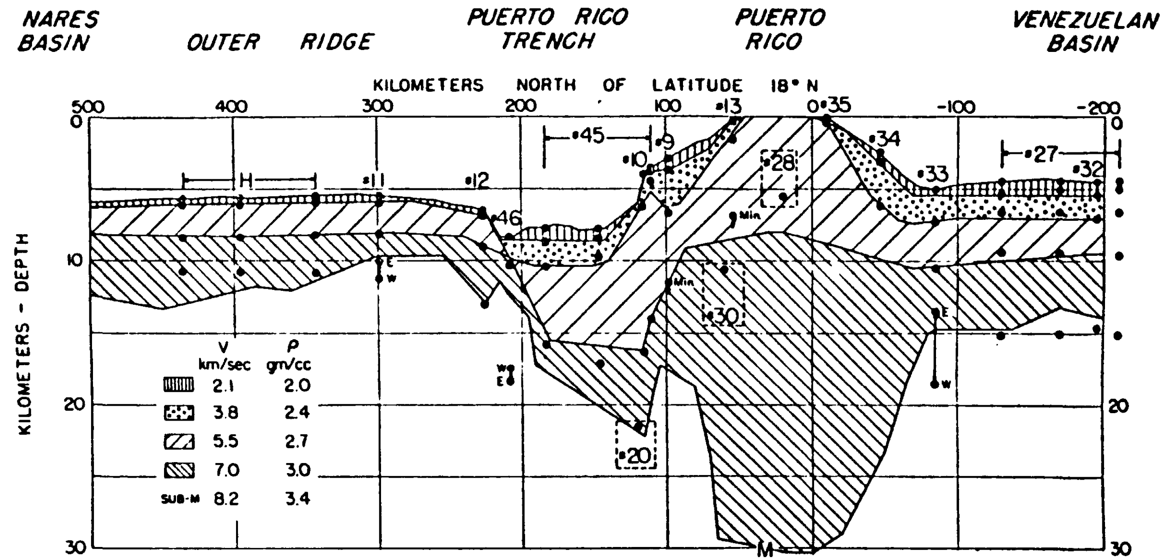


Figure 12: Puerto Rico crustal section. The model consists of two layers (v_1 = 5.5 km/sec, v_2 = 7.0 km/sec) over an half-space velocity of 8.2 km/sec. Crustal layering is from seismic data; M is from gravity data; points are seismic interfaces, (after Talwani et al., 1959).

coordinates (x,y,z) and the time (t). If the arrival times at 4 seismic stations provide 4 independent equations, a solution can be obtained for each unknown. Because a micro-earthquake network usually consists of more than four stations, the solution becomes an overdetermined system of linear equations. The usual method to solve an overdetermined system is by least squares.

Difficulties to solve for an overdetermined system of linear equations were found in this study particularly for events lying outside of the network. Mathematically, the solution to a set of linear equations is determined by the travel time derivatives, which in turn, depend on the seismic ray takeoff angle to the observed station and the velocity values of the observed seismic wave at the trial hypocenter. If the matrix that contain the travel time derivatives has a column that is nearly a multiple of another column, as in the case for earthquakes outside the network, the set of linear equations is not linearly independent, some computational difficulties may arise.

This computational problem can be reduced introducing later arrivals. Later arrivals will have different values for the travel time derivatives than P-arrivals and this reduces the dependent columns in the matrix (Lee, 1979). For earthquakes in the Mona Canyon and Mona Passage the use of S-wave arrivals made possible the determination of the hypocentral location.

Errors

In any location procedure, it is important to estimate possible errors of location. Two methods are used in this study, standard errors and prediction analysis.

Standard errors - this method estimates standard errors of each of the calculated solution parameter, for each event located, via the least-squares procedure, assuming random errors in the input parameters, i.e. errors in reading arrival times and station coordinates. The standard errors vary from 2 to 5 km in the horizontal (x-y coordinate) and vertical plane. Root mean square of the time residual are within 0.20 seconds. Standard errors and time residual are listed for each event located in the Western Puerto Rico Region in Appendix C. This method has the disadvantage that it is difficult to visualize the way in which errors are distributed over the entire array.

Prediction Analysis - The purpose of prediction analysis is to predict the values of standard deviations of the unknown parameters as a function of all the known parameters and variables. (Wolberg, 1967). This approach was used by Peters and Crosson (1972), and Johnson (1975) to estimate relative errors and relative difficulty of location as a function of hypocenter position given as known parameters the array geometry and crustal model.

The method lends itself to visual presentation by means of contour mapping of the relative errors over an arbitrary array geometry.

In general, using very simple models, like a constant velocity half-space, the method indicates very well the regions where location is difficult. A layered earth model increases the parameter resolution. Figures 13 through 16 represent the error contour for the Puerto Rico Region using the 1976 station configuration. Each map was generated assuming the following.

a. All stations record all events.

b. Station locations have no error.

c. Errors are randomly distributed (timing errors).

d. Velocity model has error of 0.1 km/sec

e. Standard deviation in the arrival time is 0.2 km.

f. The crustal structure model is a constant velocity half-space with velocity $V_p = 6.2$ km/sec. with the events placed at 20 km in depth.

The relative error for each of the parameters (x,y, z, and t) are very low inside the island, this is due to the station distribution. Errors increase uniformly outside of the island in the horizontal plane. However, depth control is very poor outside the island block itself. Origin time resolution is generally smooth in the island, this

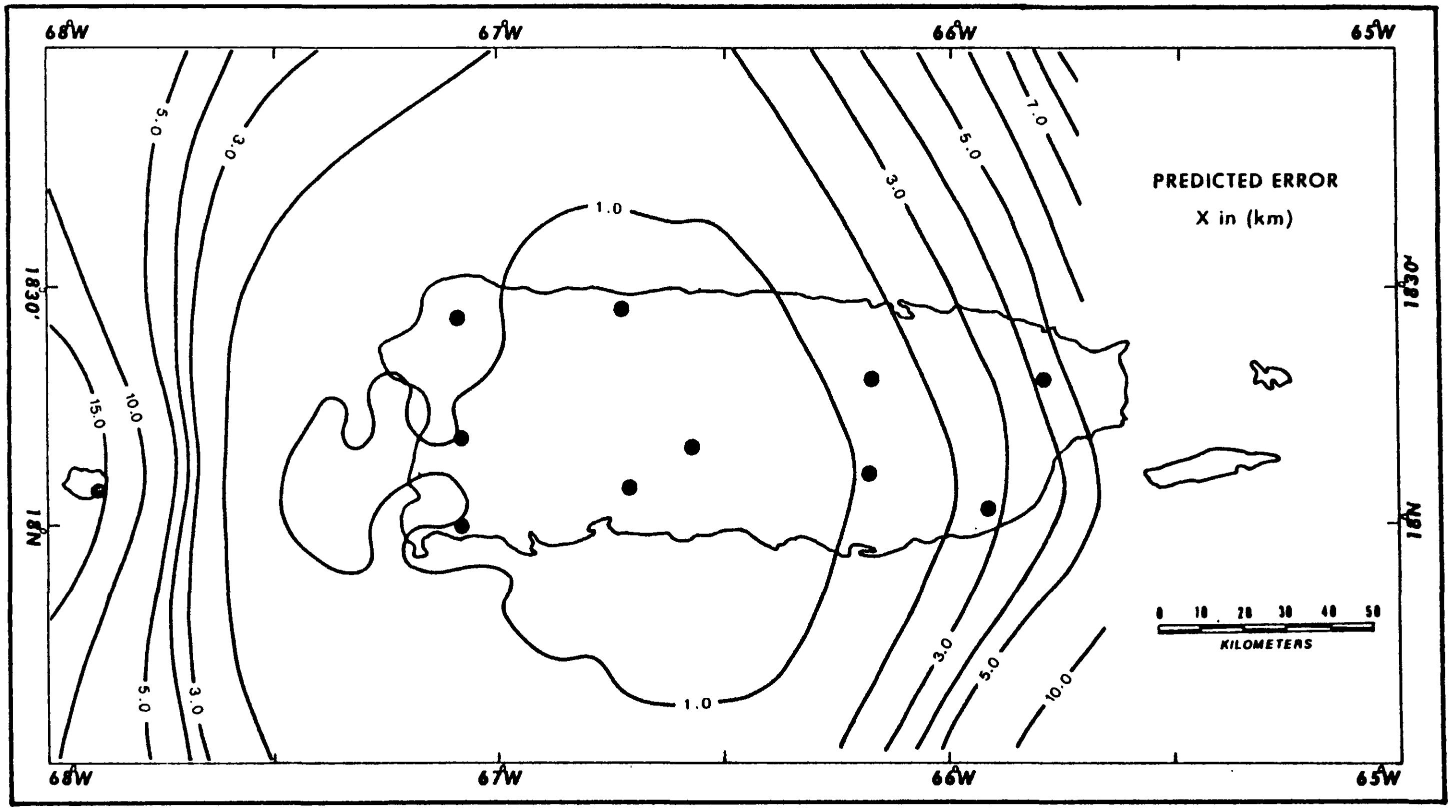


Figure 13: Predicted error contour map in the X (latitude) direction. Dots represent stations. The crustal model is a constant velocity half-space, v_p = 6.2 km/sec. Velocity model has an error of .1 km/sec. for events at 20 km in depth. Comments apply to the next three figures.

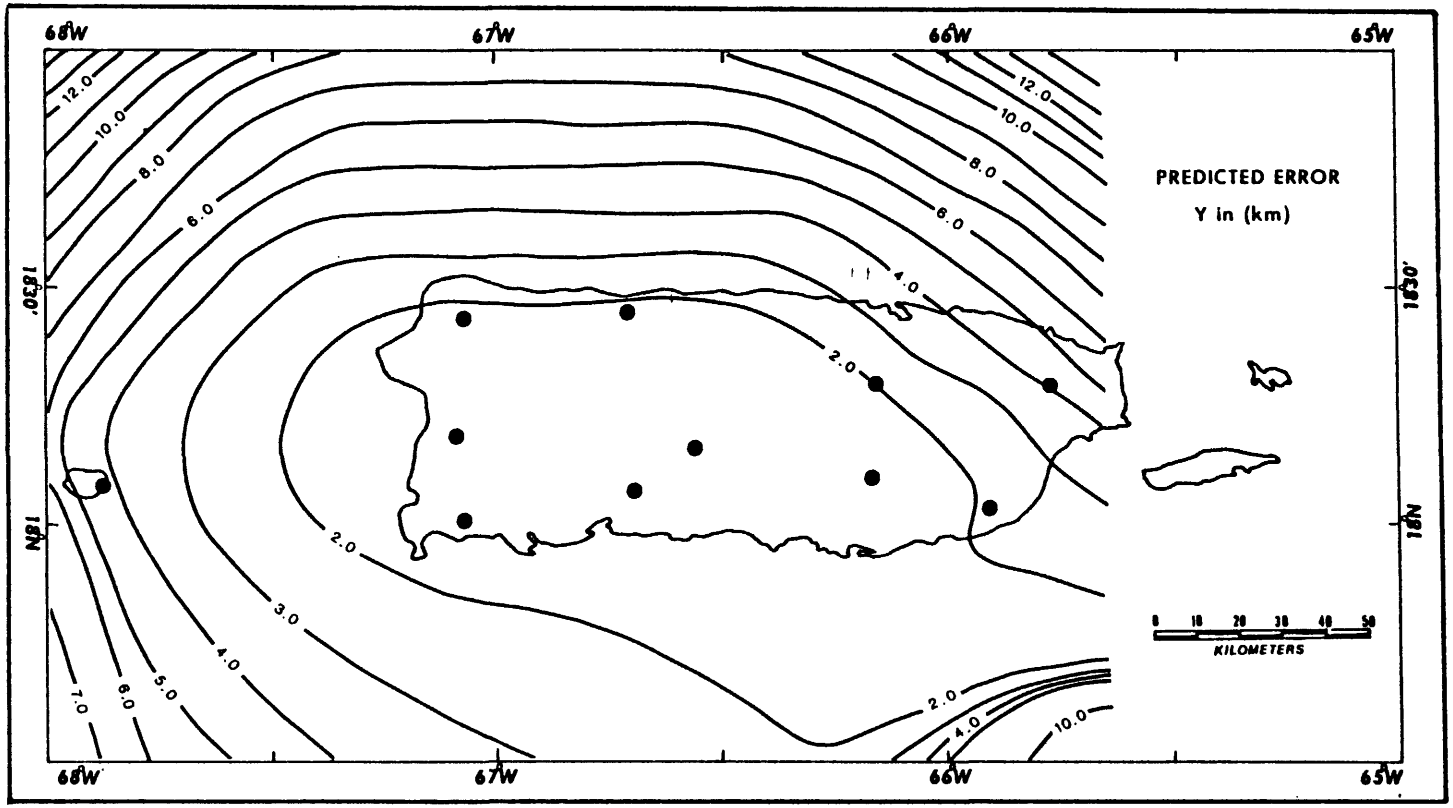


Figure 14: Predicted error contour map in the Y (latitude) direction.

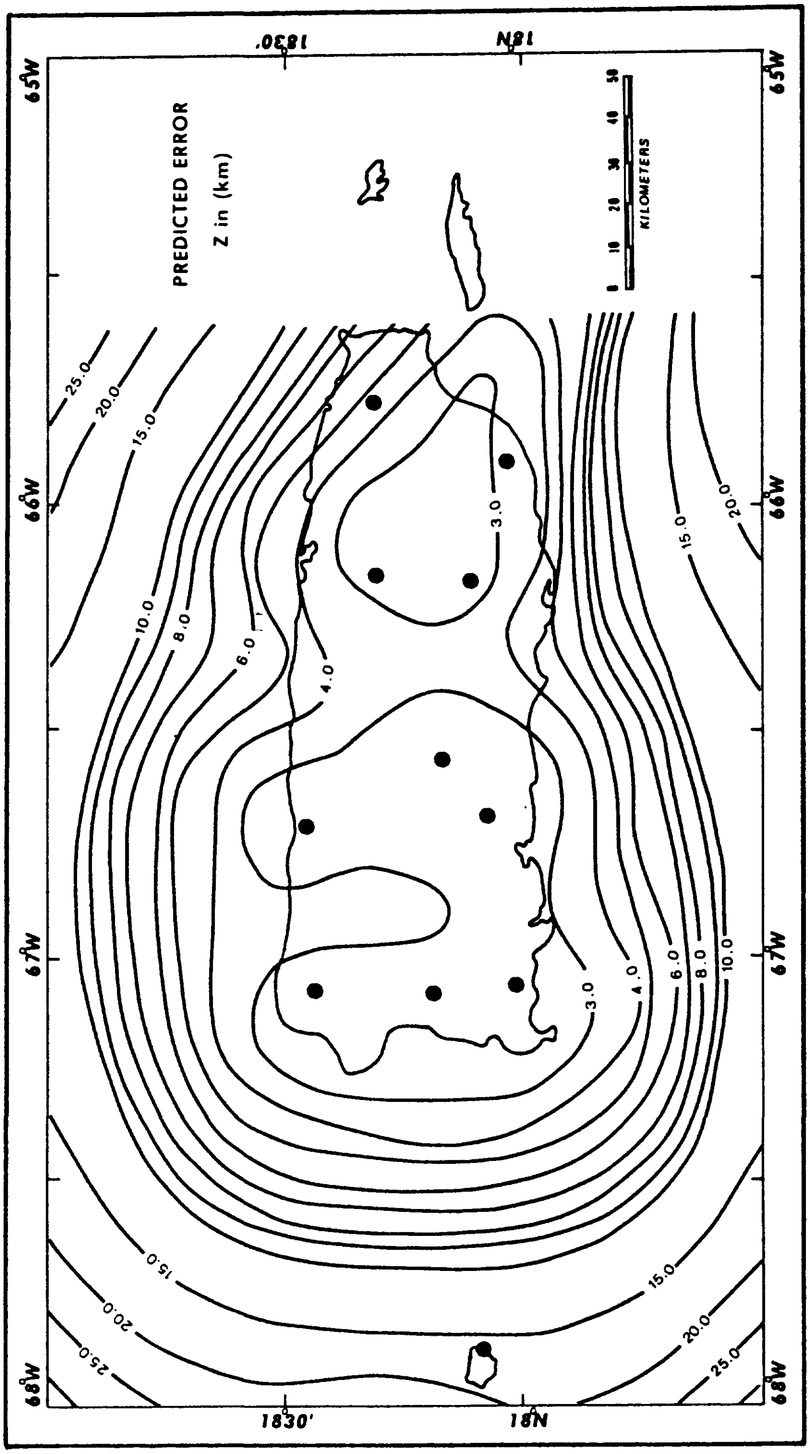


Figure 15: Predicted error contour map in the z (vertical) direction.

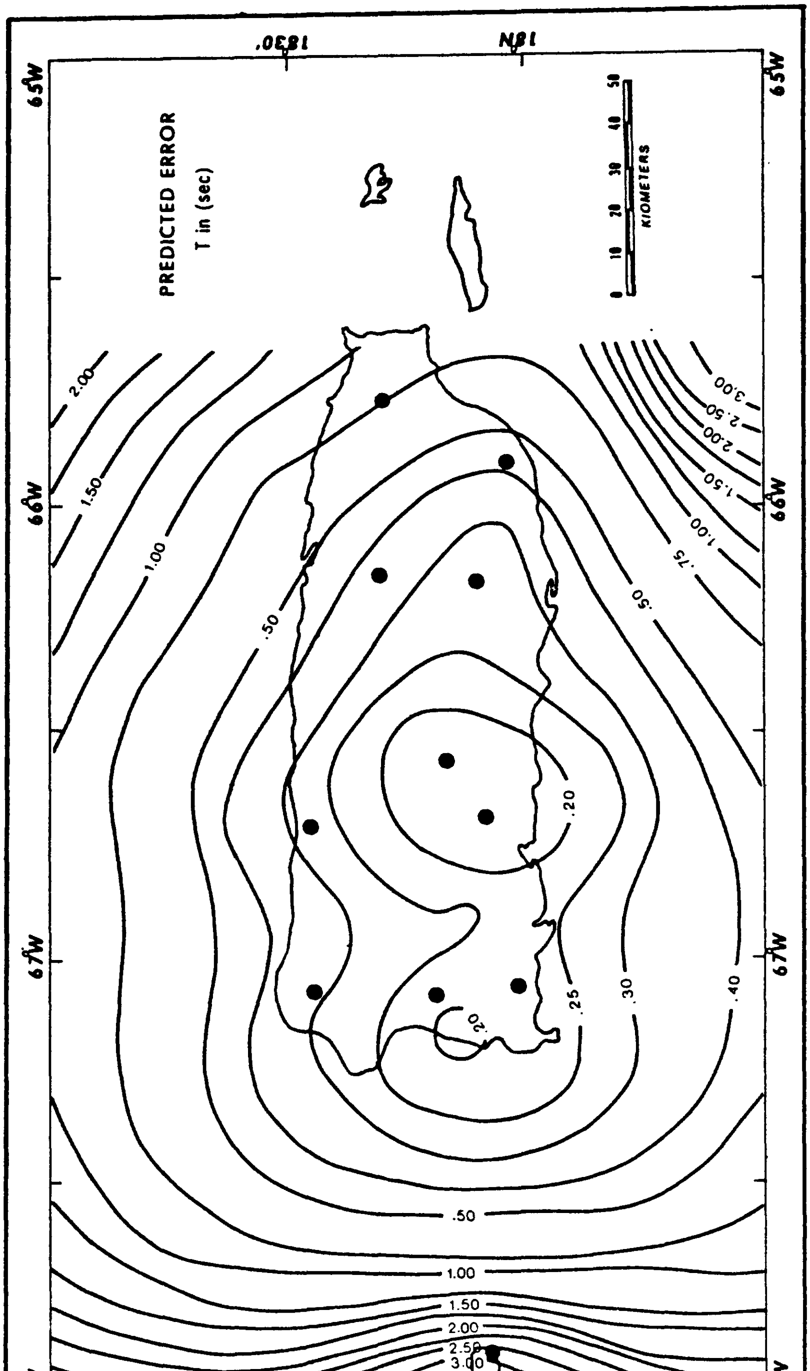


Figure 16: Predicted error contour map in the original time.

resolution decreases as distance outside the island increases.

The reader should remember that each map displays relative errors and relative difficulty of location as a function of hypocentral position. They are not an indication of absolute error associated with a particular event.

Statistical Properties

Magnitudes

Richter magnitudes were estimated for local earthquakes in the Puerto Rico region using the signal duration method (Lee, et al., 1972). Because of the lack of Wood Anderson records, conventional local magnitudes (Richter, 1958) could not be determined. To evaluate the uncertainties in the determination of magnitudes, body wave magnitudes (m_b) were determined from duration magnitudes (Richter, 1958, p. 366).

These m_b values were compared with the body wave magnitudes reported in the Preliminary Determination of Epicenters Bulletin, published by the National Earthquake Information Service (NEIS). Only six shallow earthquakes, $h < 70$ km, magnitude $m_b > 4.3$ were reported within this region from 1976 to April 1979 (see Table 6). The calculated body wave magnitude and the teleseismically determined m_b value are remarkably similar. Not enough data is available to permit a valid statistical analysis. However, the standard deviation of $(m_b - \hat{m}_b)$ is very small, thus indicating that relative magnitude is reliable and magnitude-frequency relationship is valid.

TABLE 6

NEIS m_b MAGNITUDE VERSUS CALCULATED $\hat{m}_b$ MAGNITUDE

Earthquake Date	Time	NEIS m_b	Calculated $\hat{m}_b$
76 03 13	1906	5.4	5.25
76 06 14	0437	4.9	4.74
76 06 16	1635	5.1	4.95
77 04 05	0227	4.8	4.52
77 05 02	1601	5.2	5.02
77 05 15	1925	4.3	4.45

$$\sigma = \left[\sum_{i}^{n} (m_b - \hat{m}_b)_i^2 / n \right]^{1/2}$$

$$= .1855$$

Where m_b = observed NEIS magnitude

$\acute{m}_b$ = calculated magnitude

Magnitude--Frequency Relationship

The distribution of earthquakes can be expressed by the Gutenberg-Richter relationship:

$$\text{Log}_{10}\ N_m\ dM = (a - bM)\ dM$$

where N_m is either the incremental or cumulative number of earthquakes of magnitude M, dM denotes the range or class interval, and a and b are empirical constants. The incremental number is defined as the number of earthquakes within a selected magnitude interval range.

Magnitude-frequency constants are useful only if the data set is statistically complete and the method of calculation is clearly described. Also, it has been shown by Karnik and Prochazkov (1971) that the empirical constant b calculated using the cumulative number of earthquakes is either equal or higher than b calculated using the incremental number of events.

In this study, the data set was grouped into classes dM=0.3. Two methods were used to determine values of b: 1) the method of least squares based on the Gaussian distribution of random values of Log N, (conventional linear regression), 2) weighted least squares which introduce weights to the individual number of occurences.

Computations were made for four regions or zones: 1) Western Puerto Rico Region (latitude 17.5° N - 19.0° N, longitude 68° W - 66.5° W), 2) Island Block Region (latitude 18°N - 18.5° N, longitude 67.75° W - 66.5° W), 3) Offshore Region (consisting of the Western Puerto Rico Region except the Island Block Region), 4) Northeastern Caribbean Region (latitude 16° - 20.5° N, longitude 62° - 72° W).

Body wave magnitudes (m_b) reported by NEIS, observed between 1964 and 1977, were used to determine a and b constants for the Northeastern Caribbean Region. Table 7 lists the values of b for each region and Figures 17 through 20 show the incremental and cumulative numbers of events over the entire range of observable magnitudes.

In general, b values differ from region to region and method to method. A better fit to the data was obtained using the weighted least squares method. For the offshore and onshore regions, b decreases as the earthquake activity increases and vice versa. The Northeastern Caribbean is characterized by a high b value, but this value can not be compared to the Western Puerto Rico Region because m_b magnitudes and a larger time period (T = 13 years) was used for the calculations.

TABLE 7

VALUES OF b DETERMINED FOR THE WESTERN PUERTO RICO REGION AND THE NORTHEASTERN CARIBBEAN REGION (1962-1977)

Region	Class Interval (dM)	Magnitude Range	Number of Earthquakes	Method (*)	Constants a	Constants b
A. Western Puerto Rico Region	0.3	2.04-4.03	102	(1)	3.46	0.86 ± .12
				(2)	3.19	0.74 ± .02
B. Offshore Region	0.3	2.0-4.3	72	(1)	3.09	0.76 ± .10
				(2)	2.86	0.67 ± .02
C. Island Block Region	0.3	1.9-3.2	33	(1)	2.93	0.88 ± .29
				(2)	2.57	0.70 ± .09
D. Northeastern Caribbean Region	0.3	4.6-6.6	150	(1)	6.83	1.05 ± .10
				(2)	7.04	1.09 ± .01

Method (*)
(1) Least square and associated standard error
(2) Weighted least square and associated standard error

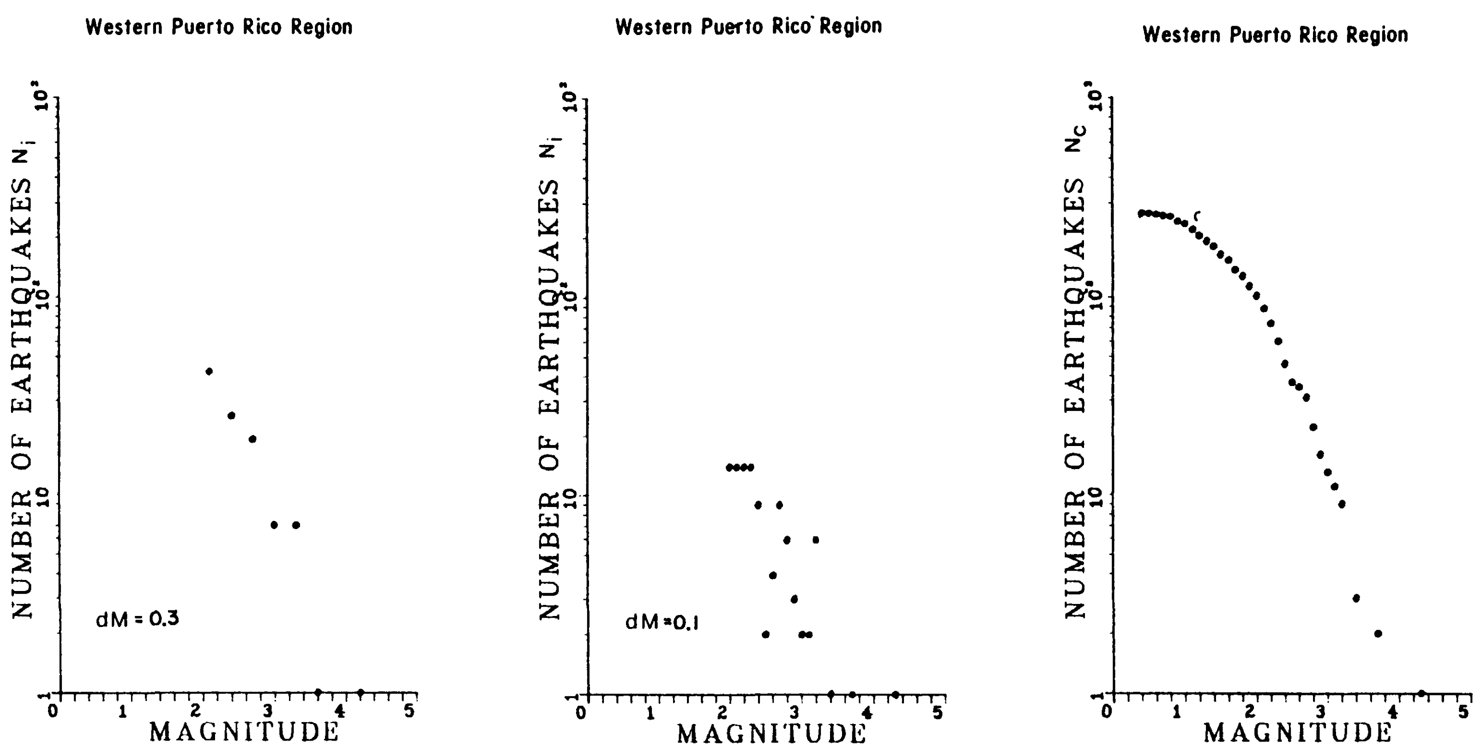


Figure 17: Magnitude - Frequency relationship for earthquake in the Western Puerto Rico Region. N_i, denotes incremental and N_c denotes cumulative distribution of magnitudes, dM denotes class interval. Notations are used through figure 20.

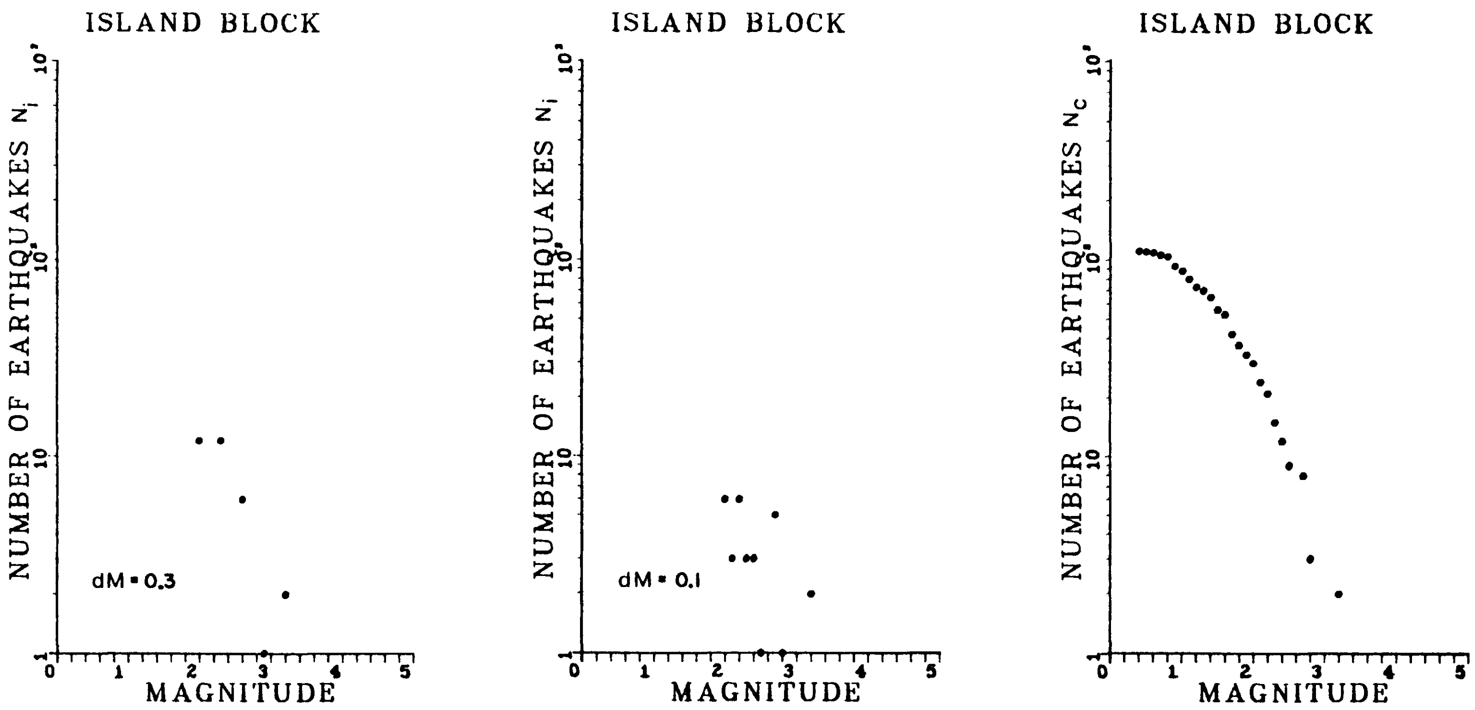


Figure 18: Magnitude - frequency relationship for earthquake inside the island. (see text for area distribution).

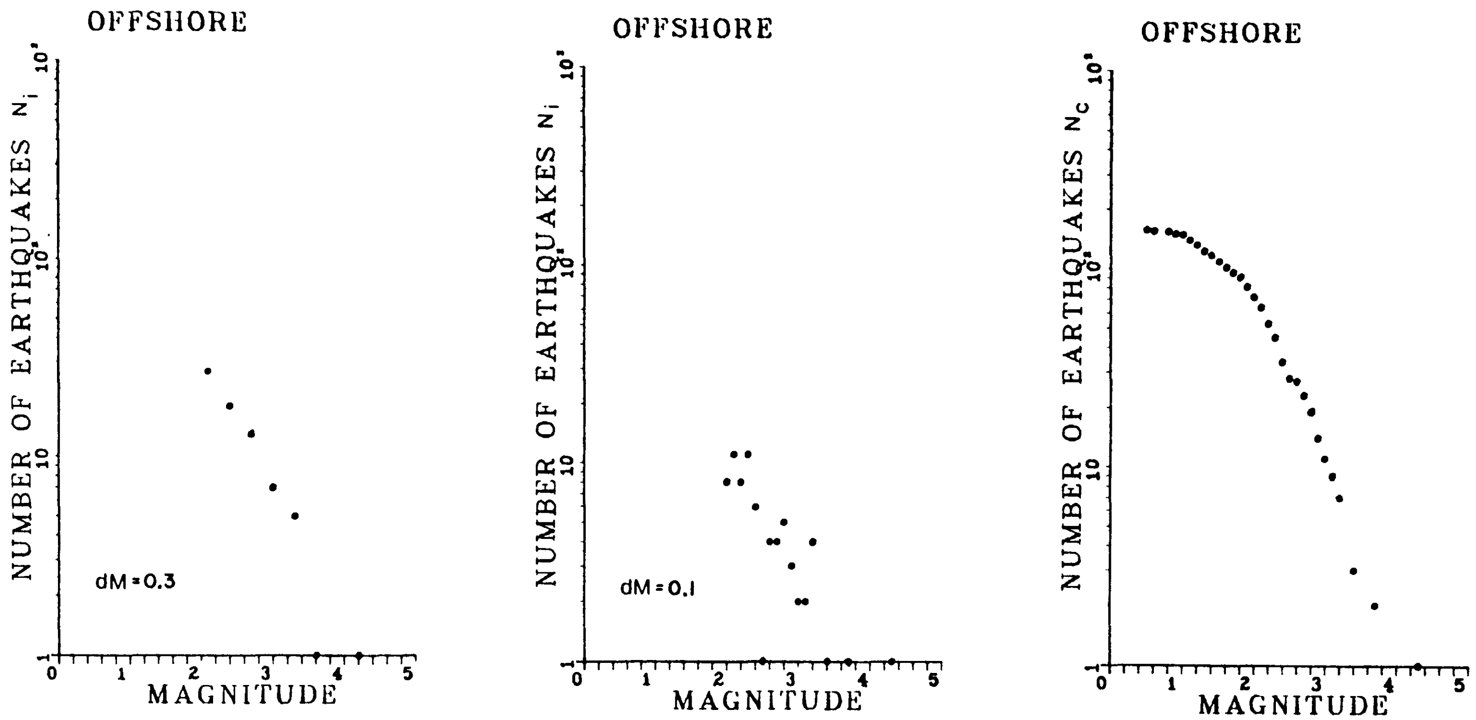


Figure 19: Magnitude - frequency relationship for earthquakes outside the island. (see text for area distribution).

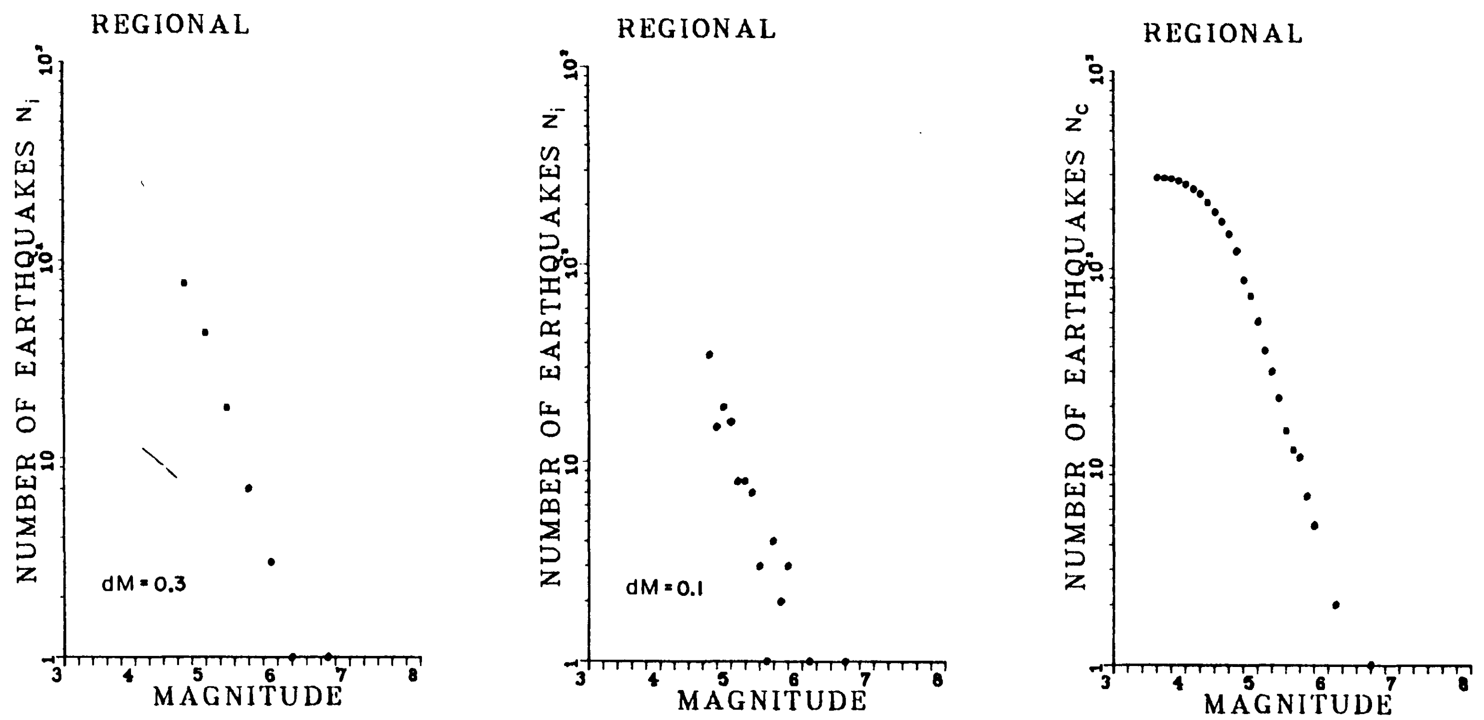


Figure 20: Magnitude - frequency relationship for earthquakes along the Northeastern Caribbean Region.

<u>Western Puerto Rico Micro-Seismicity</u>

The earthquakes used in this study were recorded between February 1976 and January 1977. The data were divided into two groups based on the number of observations of P and S arrivals available for each event. Locations were first obtained for 134 local events using nine observations or more. This particular set of data was used in the modelling crustal structure study, the Poisson's ratio determination and composite focal mechanism. Once a reliable model was determined, earthquakes with five observations or more were located and studied, with particular emphasis on small earthquakes inside the island. The results of the second group do not change the picture provided by the first group. A total of 268 local events were located. Figures 21 and 22 show the epicenters of the located earthquakes using nine or more observations and five or more observations, respectively. Appendix C list all the calculated solutions including the number of observations, magnitude, and errors.

A depth cross-section projecting all the located events in the region along longitude 67°W is shown in Figure 23. Most of the seismic activity is concentrated in the earth's crust to a maximum depth of about 30 km. A more diffuse south dipping zone of activity can also be identified up to a maximum depth of 155 km.

Figure 24 shows the distribution of earthquakes along latitude 18°N. The plane that sustain the intermediate -

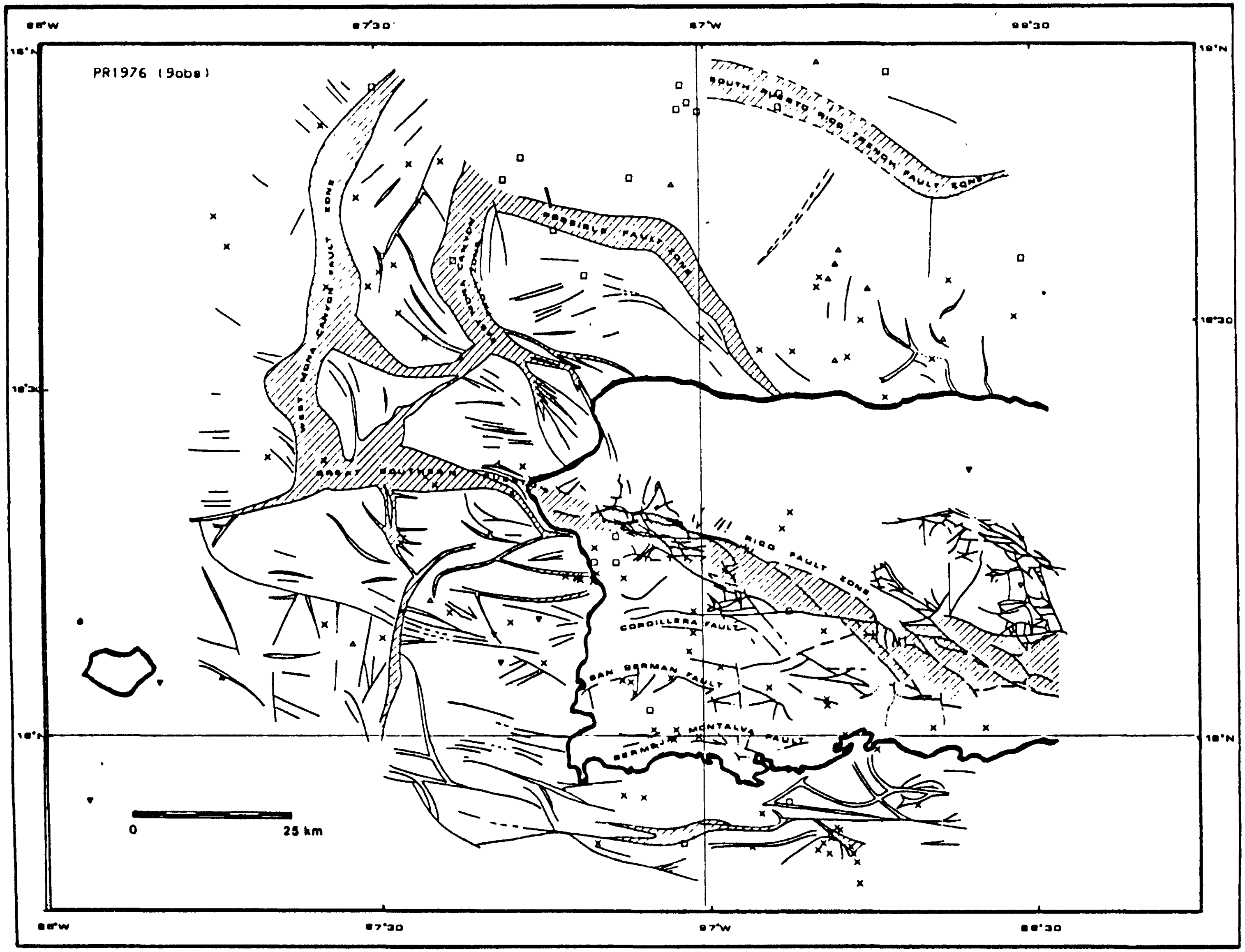


Figure 21: Western Puerto Rico Seismicity. Earthquakes located using nine or more observations. Symbols: ✖ denotes epicenter at depth < 25 km, □ depth, >25, and ≤ 50 km, △ depth, > 50 and ≤ 100 km, ▽ depth, > 100 km.

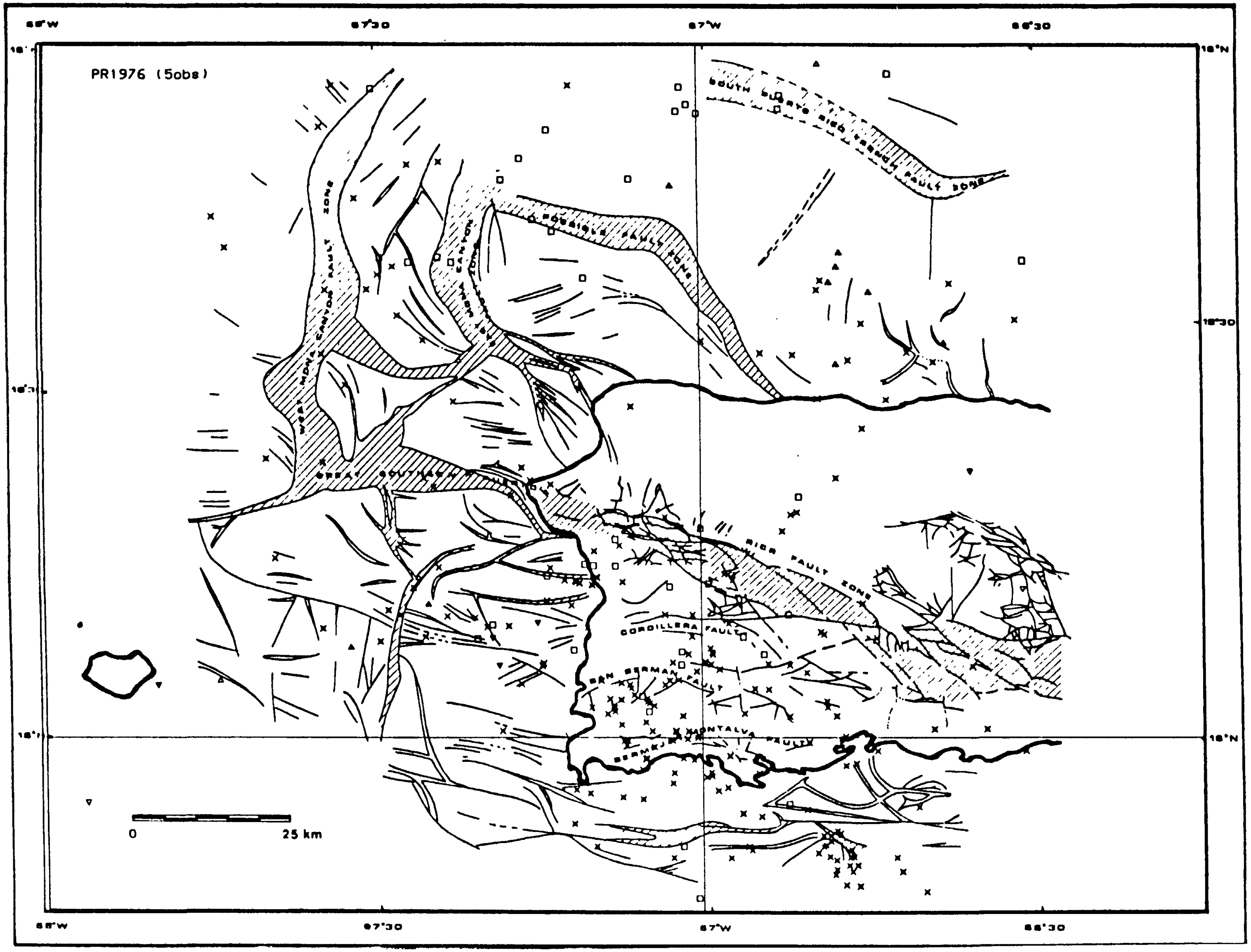


Figure 22: Western Puerto Rico Seismicity. Earthquakes located using five or more observations. Symbols: ✖ denotes epicenter at depth $\leq$ 25 km, □ depth, > 25 and $\leq$ 50 km, △ depth, > 50, and $\leq$ 100 km, ▽ depth, > 100 km.

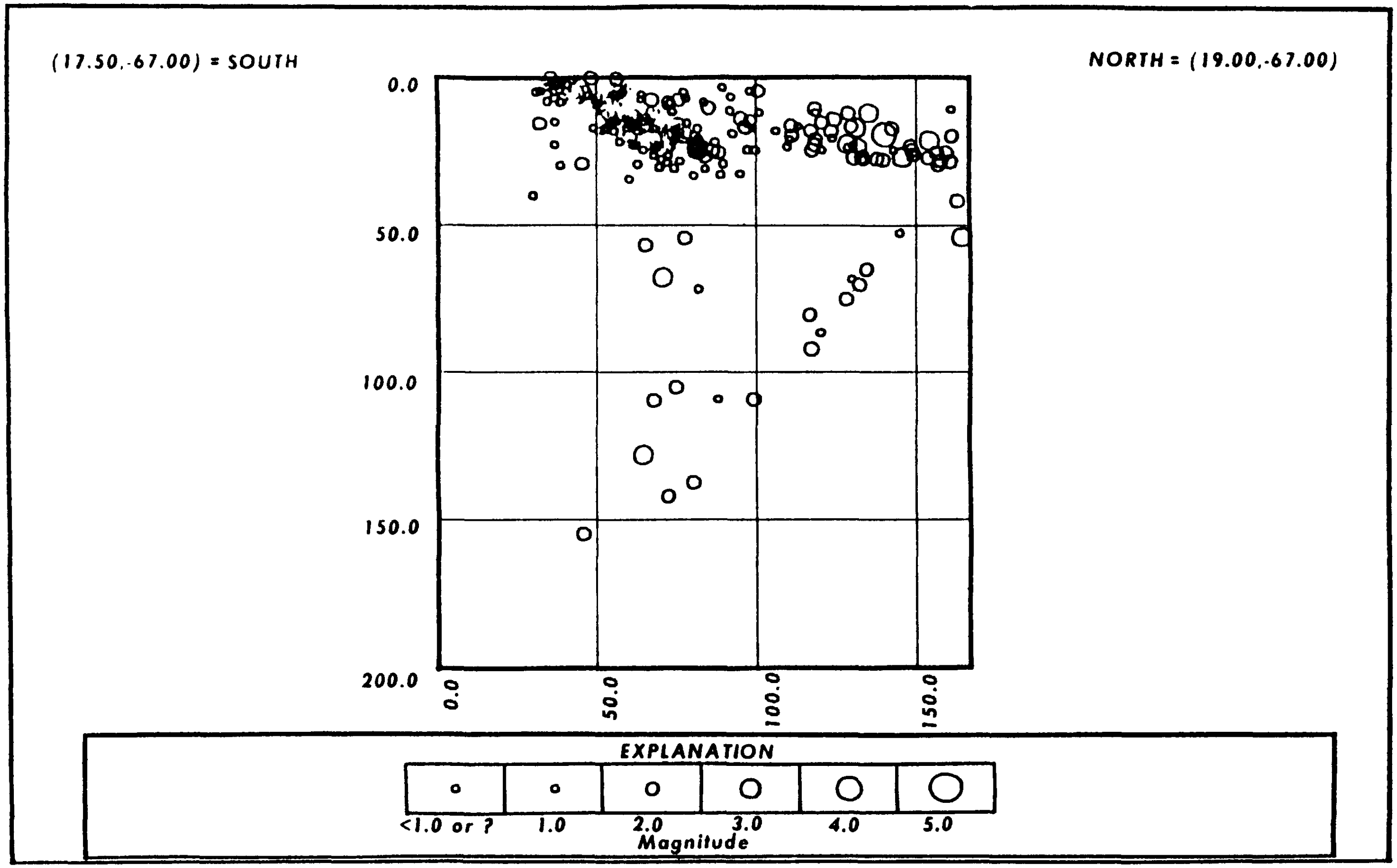


Figure 23: Depth cross-section projecting the 268 local earthquakes along longitude 67°W.

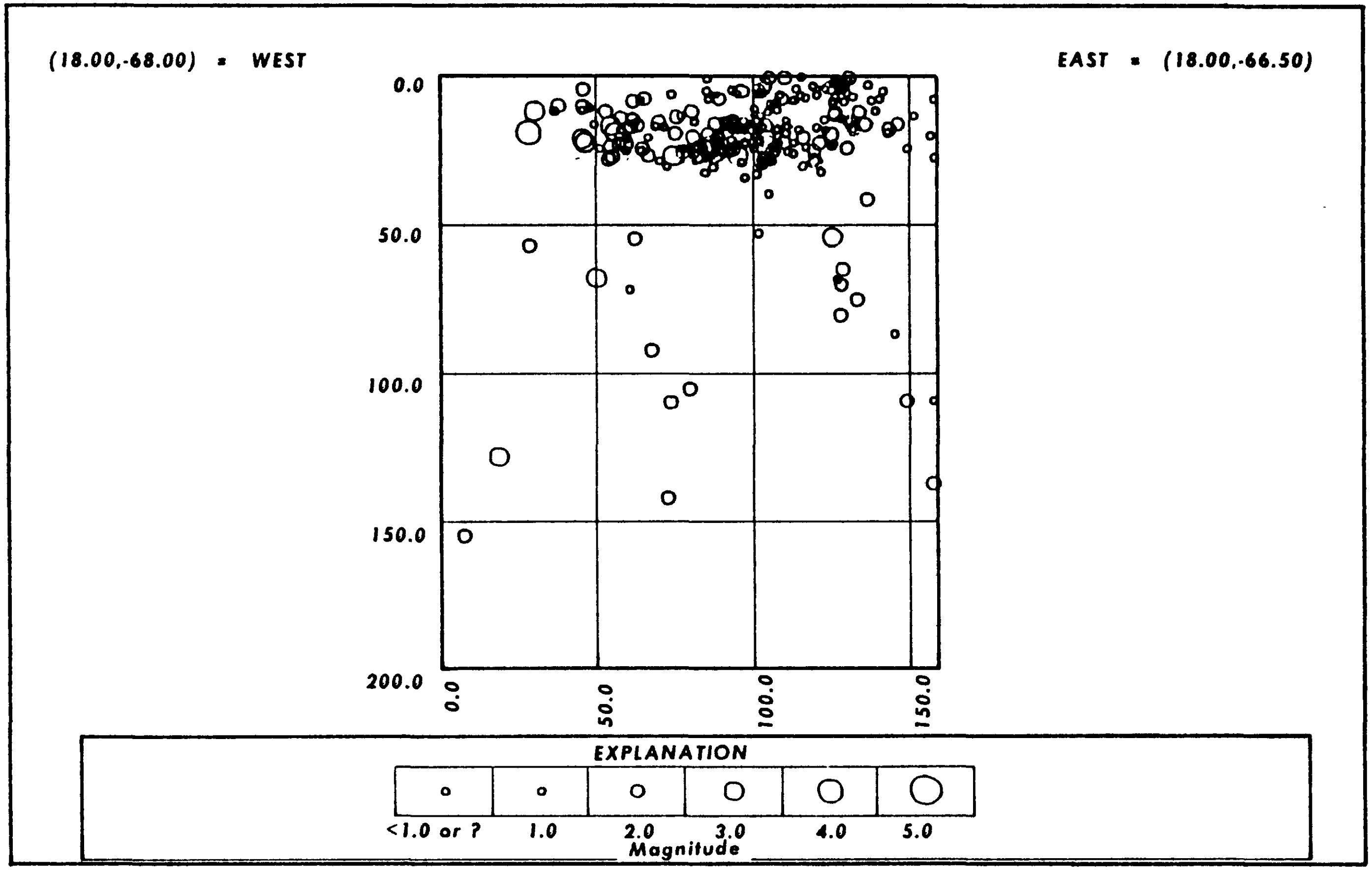


Figure 24: Depth cross-section projecting the 268 local earthquakes along latitude 18°N.

deep focus earthquakes extends along the whole region of study. This may substantiate the existence of the Benioff Zone under Puerto Rico. However, focal mechanism studies indicate motion parallel to the trench not underthrusting (Molnar and Sykes, 1969).

Epicenters are directly related to the local geologic structures mapped in the area of study. A description of these features onshore and offshore were discussed previously.

Onshore Seismicity

A large number of events in the southwestern part of the island appear to be related to the San German Fault mapped by Mattson (1960) and the Bermeja and Montalva Faults (Mattson, 1960; Almy, 1969). These structures are located south of the Great Southern Puerto Rico Fault Zone, in the Bermeja Complex of the Cordillera Central Province (Figure 22). As shown in the depth cross-section, figure 23, most of the local events inside the island occur at an average depth of 20 km. The complex geology and the diffuse patterns of the local events precluded a more comprehensive study of this area. This is due to the lack of good azimuthal control, i.e., events were not recorded by enough stations to permit a reliable P - first motion composite focal mechanism solution.

Two near-shore sequences and/or clusters of micro - earthquakes in the southwestern part of the island have been studied in detail. These are located in the Guayanilla Canyon and a fault system, trending east-west, herein called the Mayaquez Fault. This fault has not been mapped onshore.

Guayanilla Canyon

The Guayanilla Canyon, located between Ponce and Guanica, is a small bathymetric depression trending north-south to northwest-southeast.

A set of eight events, with a total of fifty-nine P-wave first motions observations was used to construct a composite focal mechanism. Figure 25 shows all the local earthquakes in the area. The focal plane solution was computed using P-wave first motion projected on the lower hemisphere of an equal area stereonet. The method used is based on a maximum likelihood argument implemented by the generation of a scored surface on a discrete grid (Dillinger, et al., 1972). For the P-solution, the computer system produces contoured fiducial regions (Pope, 1972) about the poles of the focal planes. This permits the evaluation of the quality of the solution. The focal plane solution shown in Figure 26 has the following results:

a. Fault plane: strike N45^{o}W, dip 55^{o}NE.

b. Auxiliary plane: strike N63^{o}E, dip 66^{o}SE.

c. Slip vector C: trend N27^{o}W, plunge 24^{o}.

d. Compression (P) axis: trend N173^{o}W, (N7^{o}E) plunge 8^{o}.

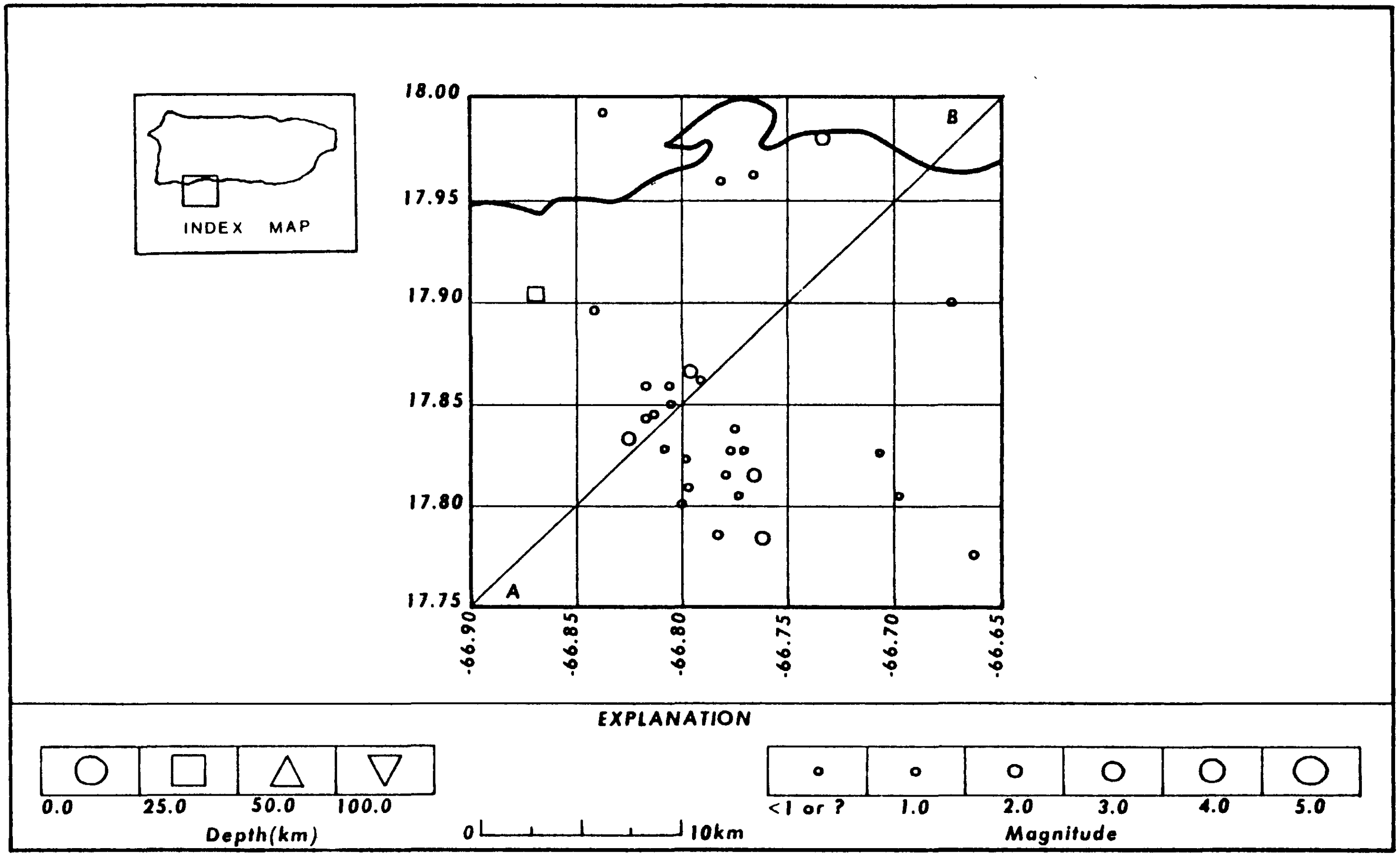


Figure 25: Spatial hypocenter distribution in the Guayanilla Canyon. Section A-B used in figure 28.

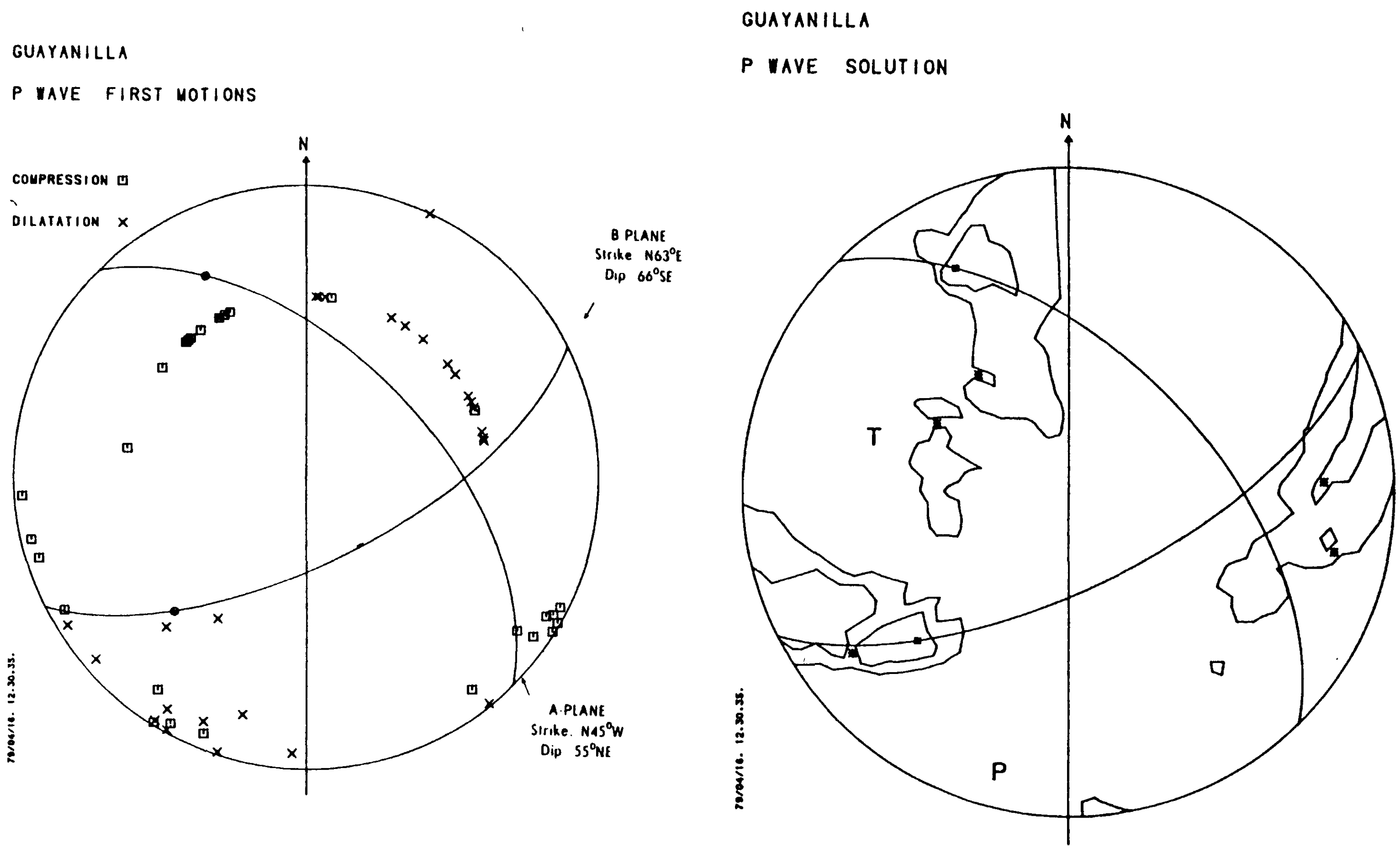


Figure 26: Composite focal mechanism solution (lower hemisphere)for earthquakes in the Guayanilla Canyon. The contour indicates fiducial levels associated with the number of observations (Dillinger et.al, 1972). Of the 59 p-wave first motion data, there are 51 consistent observations. Contour interval denotes four inconsistensies. P and T denotes compressional and tensional axis respectively.

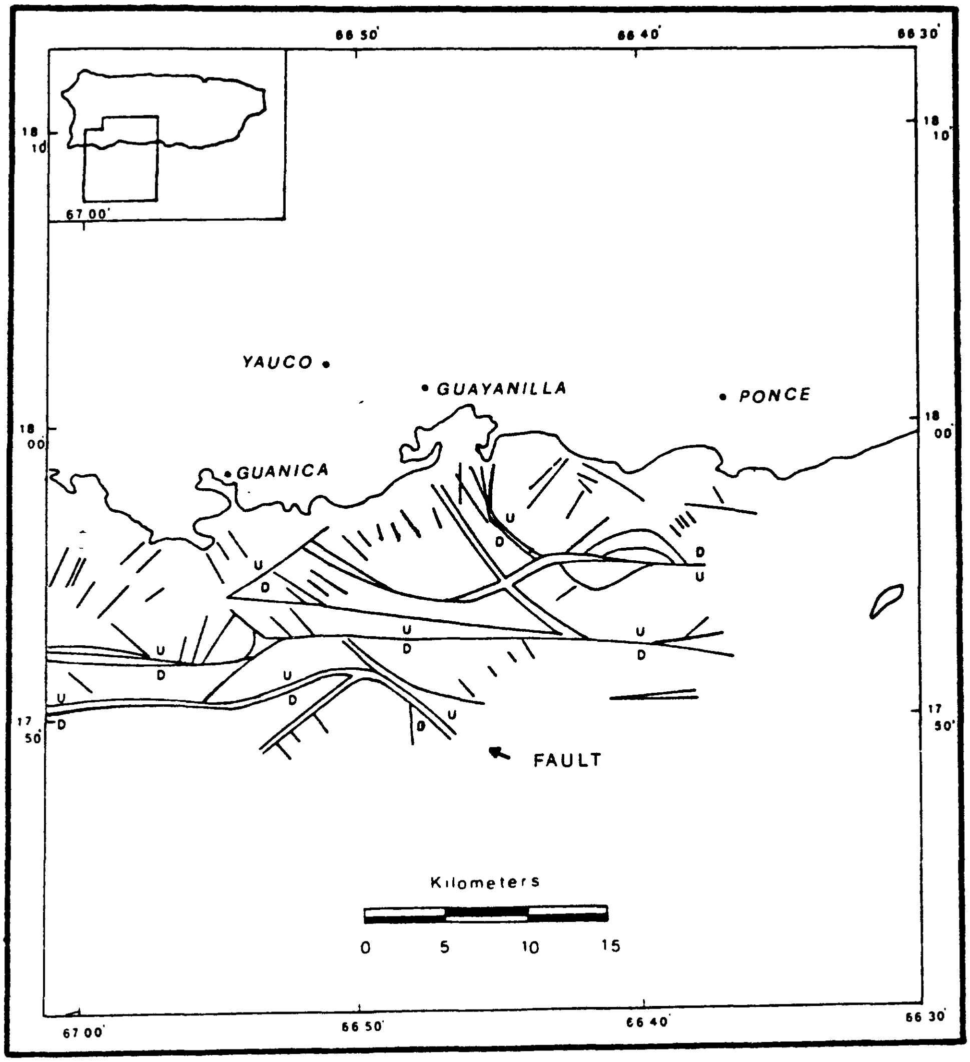


Figure 27: Offshore Structural features mapped at the base of the sedimentary section (acoustic basement) in the Guayanilla Canyon region, (modified after PRWRA, 1974). Arrow shows the fault associated with the Guayanilla Canyon earthquakes.

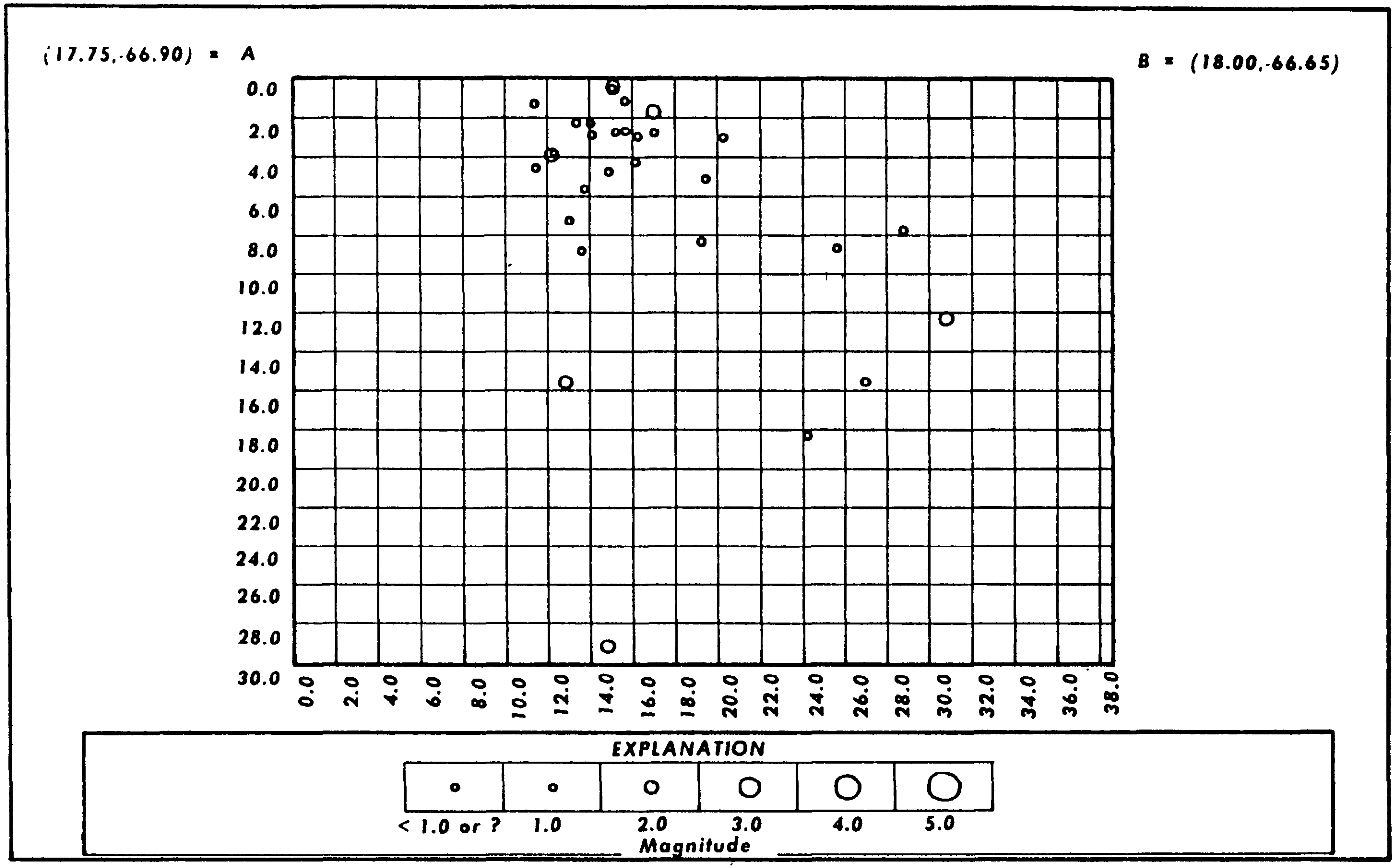


Figure 28: Vertical section showing depth distribution of Guayanilla Canyon hypocenters.

e. Tensional (T) axis: trend N77°W, plunge 44°.

f. Null (B) axis: trend N90°E, plunge 45°.

The plane striking N45°W was chosen as the fault plane because: 1) the orientation of the Guayanilla Canyon; 2) the seismicity trend; 3) structures identified in a seismic reflection survey strike in the same direction (figure 27). The diagram represents reverse faulting with a large component of right lateral movement. Figure 28 is a depth cross-section perpendicular to the strike of the fault. No prefered dip orientation is shown.

Mayaguez Fault

A linear sequence of events close to Mayaguez occurred during the month of October 1976 (inset, figure 29). The largest event of this sequence, M_D = 3.2, was felt in the city. The earthquakes occurred along a fault system trending east-west (Figure 30).

A composite focal mechanism was constructed using this sequence of events. The fault plane solution shows:

a. Fault plane: strike N60°W, dip 85°SW.

b. Auxiliary plane: strike N30°E, dip 90°.

c. Slip vector C: trend N60°W, plunge 0°.

d. Compressional (P) axis: trend N75°E, plunge 3°.

e. Tensional (T) axis: trend N15°W, plunge 4°.

f. Null (B) axis: trend N150°W, plunge 85°.

The contoured fiducial regions are large, Figure 31, but the best statistical solution confirms the expected

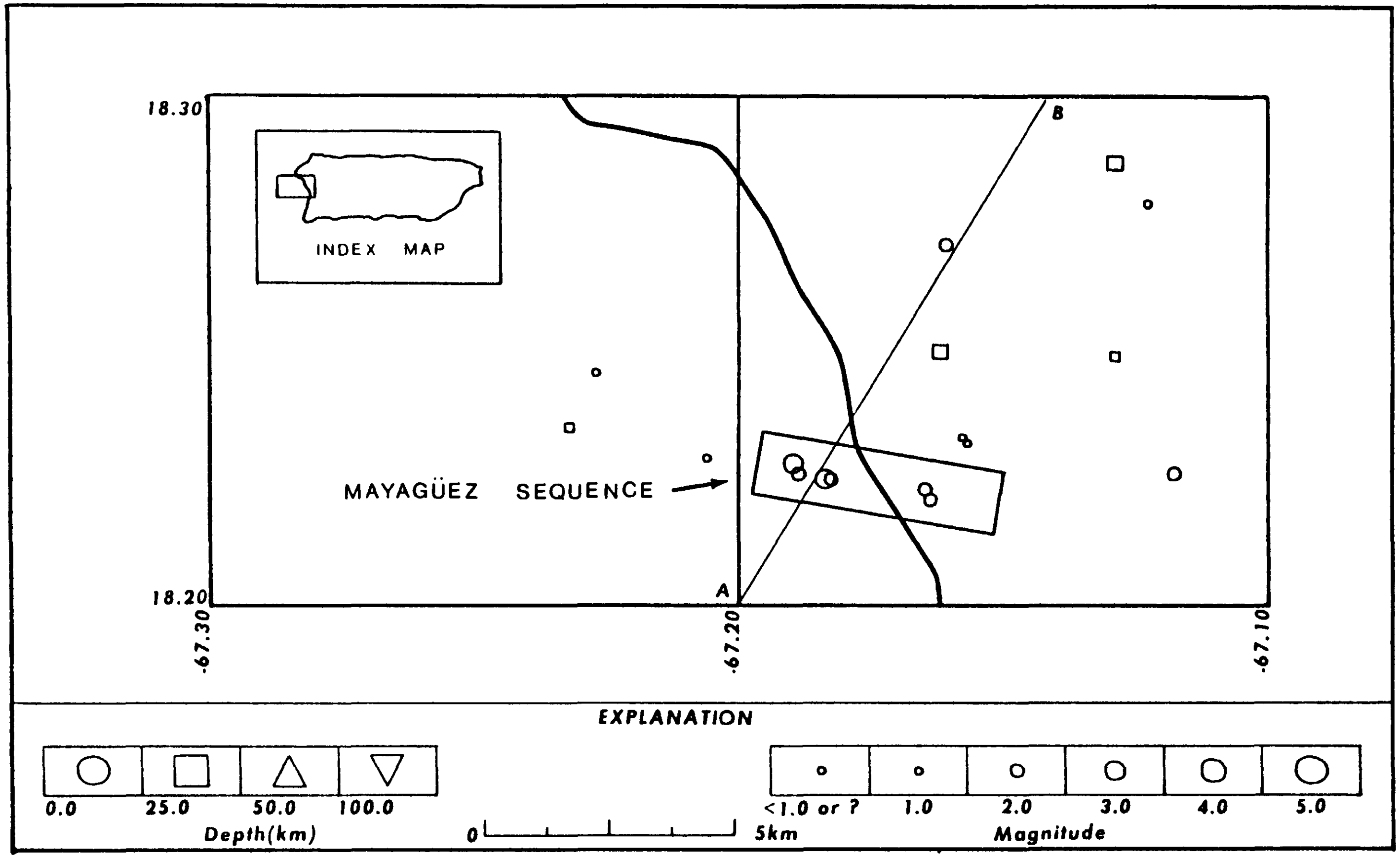


Figure 29: Spatial hypocenter distribution in the Mayaguez region. Section A-B used in figure 32.

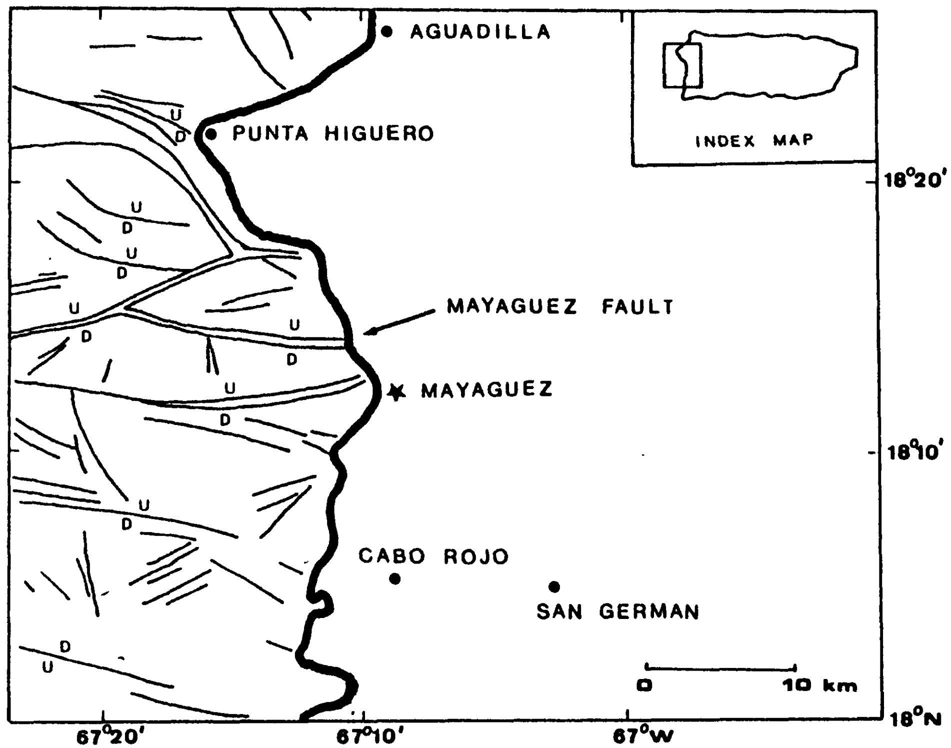


Figure 30: Offshore structural features mapped at the base of the sedimentary section (acoustic basement). Mayaguez Region, (modified after PRWRA, 1974).

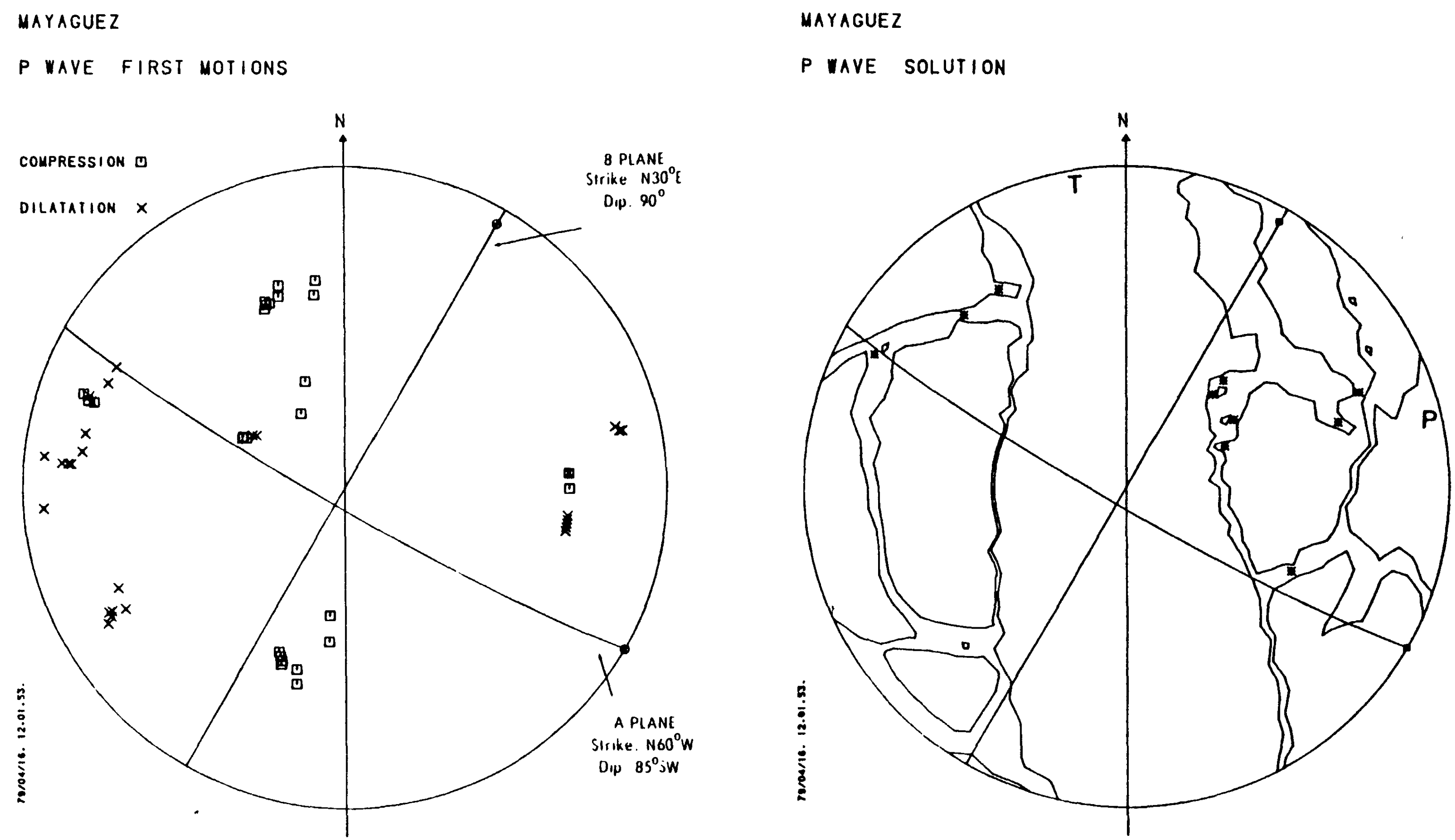


Figure 31: Composite focal mechanism solution (lower hemisphere) for the Mayaguez fault region. Contours and symbols are described in figure 26. Of the 71 P-wave first motion data, there are 62 consistent observations.

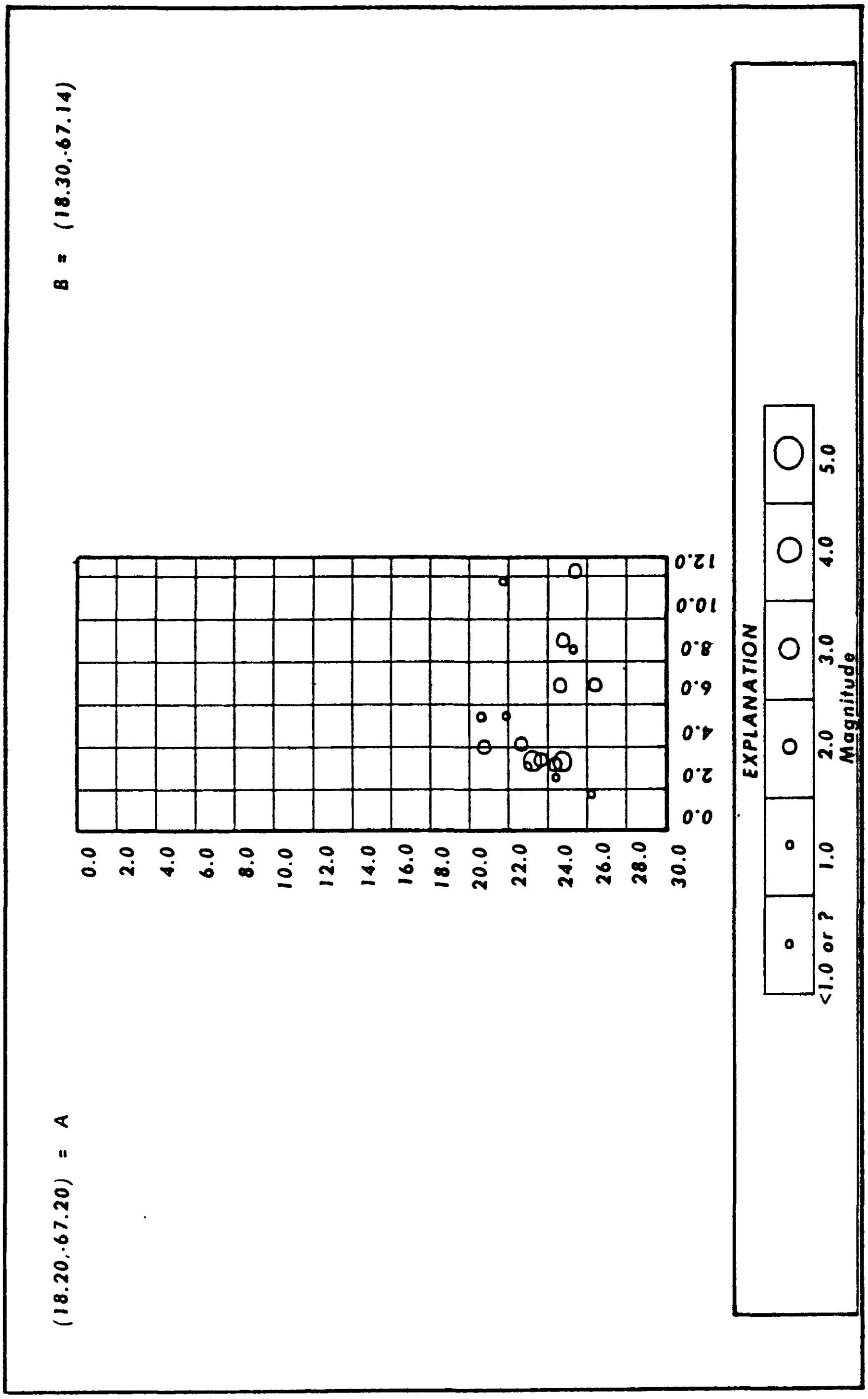


Figure 32: Vertical section showing depth distribution of the Mayaguez fault hypocenters.

trend of the fault. A depth cross-section, Figure 32, perpendicular to the strike of the fault demonstrates that the events in the sequence are nearly vertical at a depth of about 23 km.

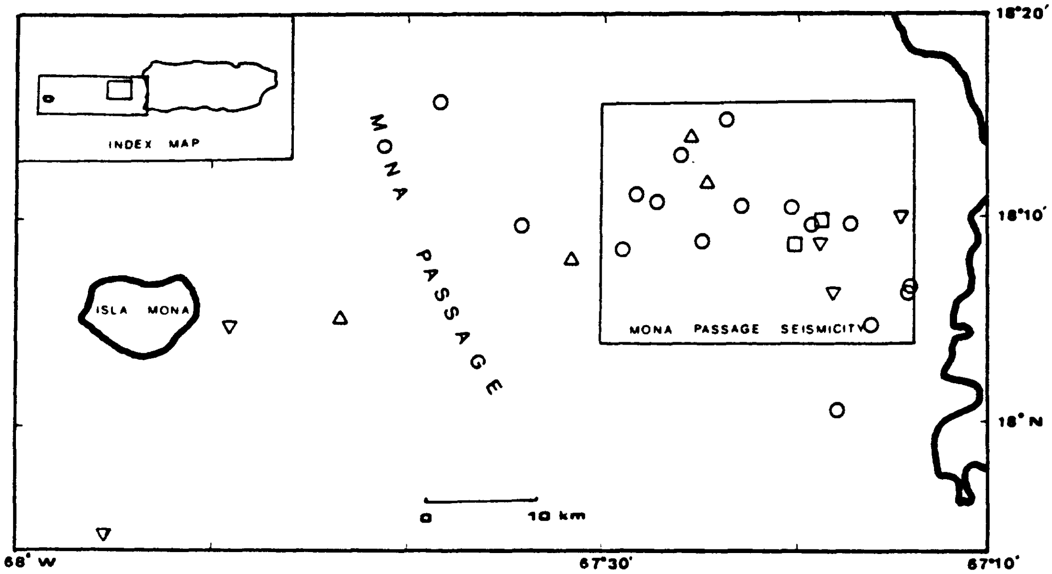
Offshore Seismicity

Mona Passage

West of the city of Mayaguez, in the Mona Passage, a diffuse sequence of earthquakes, generally trending east-west, has been identified (Figure 33). This sequence of events shows two main characteristics: a wide range of depths, and the apparent termination of shallow seismicity along longitude 67°30′ west.

PRWRA (1974), based on the complex magnetic anomalies, divided the southern part of the Mona Passage into two blocks (Figure 34). The east block, characterized by high-frequency magnetic contours, indicates a shallow magnetic basement. These anomalies are considered to reflect the seaward continuation of the serpentinite dikes, mapped on the island, separated by east-west trending structural features.

Three north-south magnetic profiles (ID-103 D, ID-105 D, and ID-107 D) are shown in Figure 35(PRWRA, 1974). The information indicates that the extension of the serpentinite body, as well as some other igneous bodies, can be correlated from line to line.



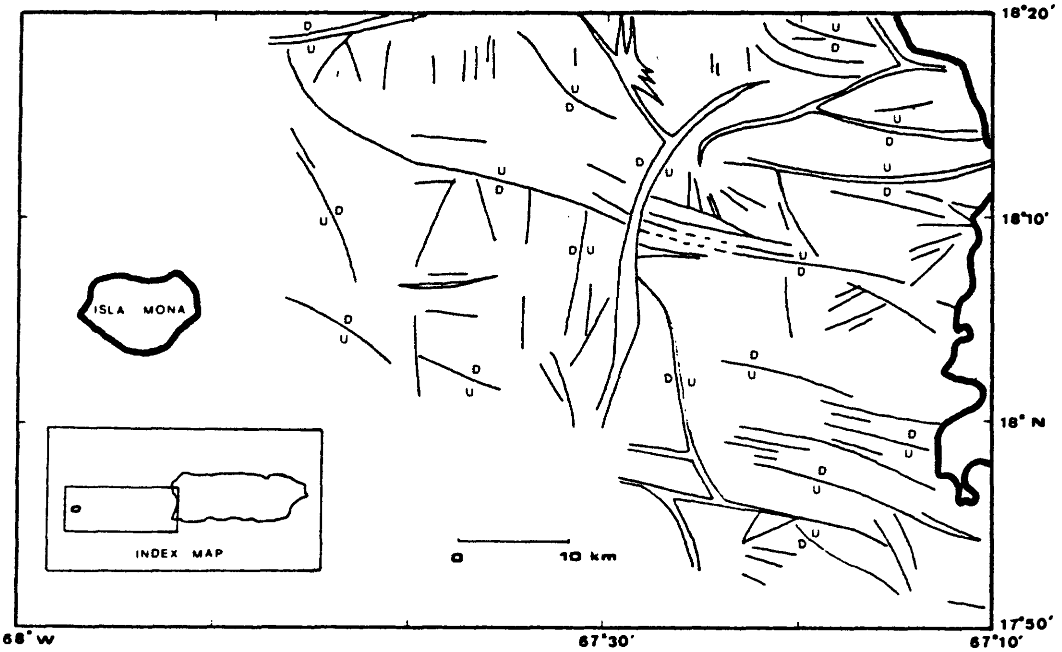


Figure 33: Spatial hypocenter distribution in the Mona Passage (above) and major structural features mapped at the base of the sedimentary section (acoustic basement),(below). Symbols : O denotes epicenters at depth ⩽ 25 km, □ depth > 25 and ⩽ 50 km, Δ depth > 50 and ⩽ 100 km, ∇ depth > 100 km.

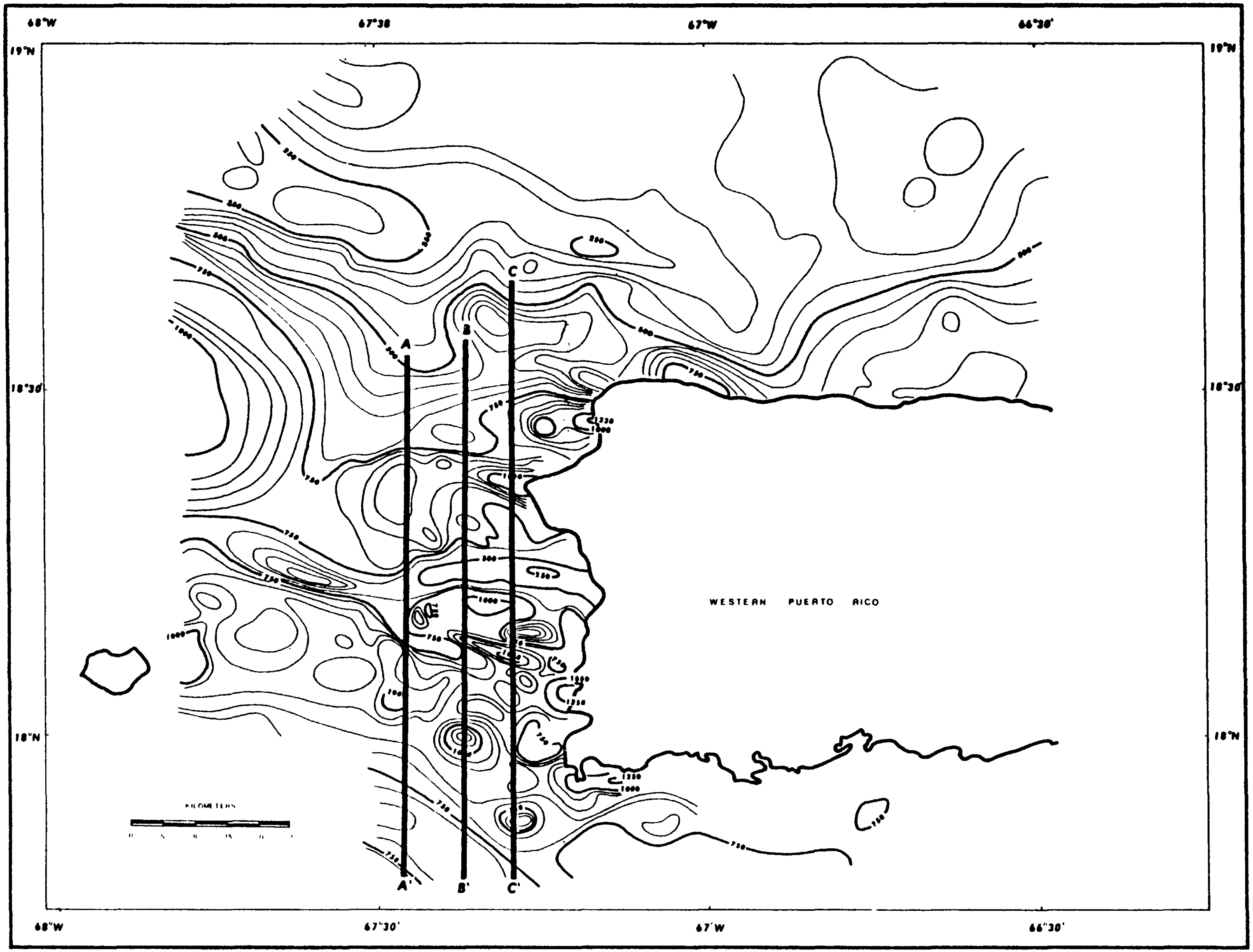


Figure 34: Total intensity magnetic anomaly map for the Western Puerto Rico region. Contour interval 50 gammas. Section A'-A, B'-B, and C'-C are used in figure 35.

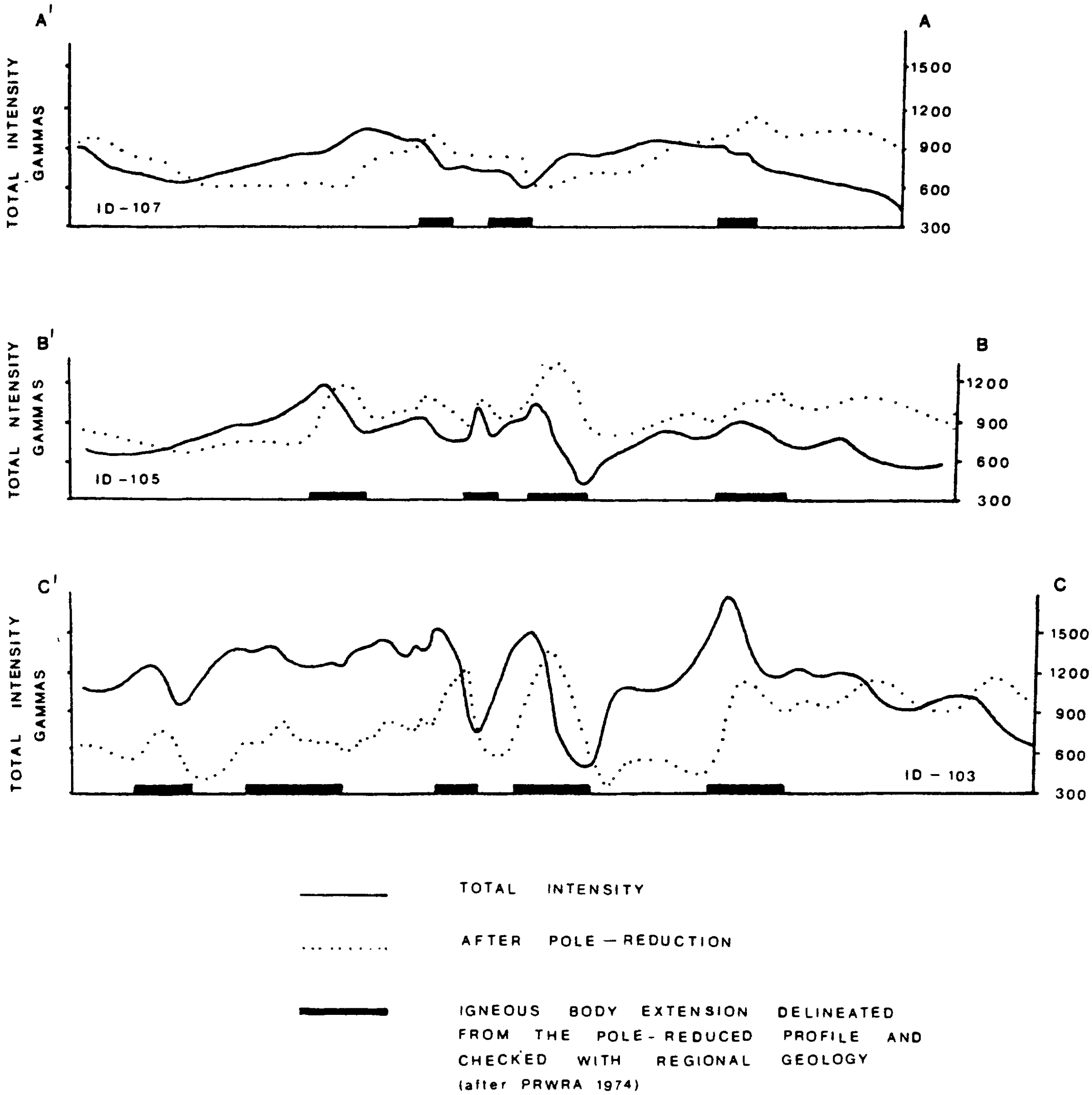


Figure 35: North - South magnetic profiles, (modified after PRWRA, 1974).

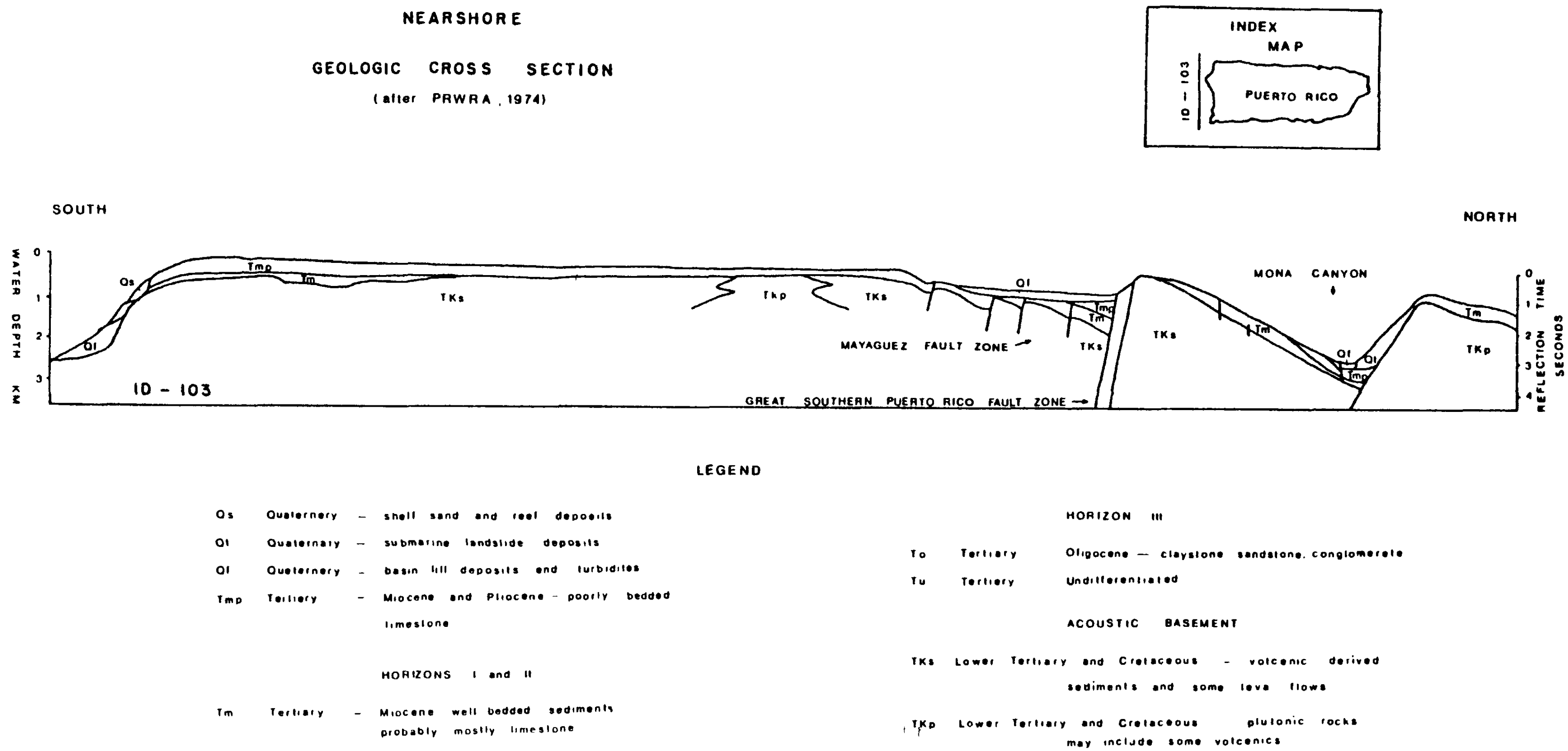


Figure 36: Geologic interpretation from seismic profile ID - 103D, (after PRWRA, 1974).

A geologic cross-section derived from the seismic section of profile ID-103 D (PRWRA, 1974), is shown in Figure 36. It seems possible from the geological and magnetic data that this sequence of local events in the Mona Passage is in one way or the other related to the serpentinite dikes or the the east-west trending structural features separating them.

Magnetic anomalies on the western block are generally gentle and simple. PRWRA (1974) believes, based on discontinuities of the seismic reflection profiles, that there is a major tectonic break between these two blocks. Moreover, most of the shallow earthquake activity is concentrated in the eastern block, and few deep events are located in the western block.

North Coast and Puerto Rico Trench

The north coast of Puerto Rico is characterized by its lack of local events. The scattered distribution of shallow earthquakes demonstrates the stability of the North Carbonate Province. Most of the seismic activity is intermediate to deep focus, probably associated with the Benioff Zone. Farther north, close the latitude 19^{o}N, the earthquakes are related to the south wall of the Puerto Rico Trench.

Mona Canyon

Earthquakes located within the Mona Canyon are poorly distributed along the major fault zones, mapped by PRWRA

(1974). The seismic activity appears to be associated with secondary faulting parallel to the major fault zones.

TECTONICS

The shallow crustal seismicity inside Puerto Rico can be divided into two seismotectonic regions. The common boundary between both regions is the Great Southern Puerto Rico Fault Zone (GSPRFZ).

The scattered shallow earthquake activity north of the GSPRFZ and relatively undisturbed middle Tertiary strata define one of the seismotectonic regions. Most of the earthquake activity is intermediate to deep focus, probably associated with the south-dipping Benioff Zone.

South of the GSPRFZ, deformation is occurring along well defined structural features. A focal mechanism solution for the Mayaguez Fault suggests that the region is deforming in response to active ENE-WSW (N75^{o}E) directed, horizontal compressional stresses. The fault trends WNW-ESE with a left lateral strike - slip displacement and may be an extension of the GSPRFZ.

Geological, geophysical, and seismological information in this study suggests that there is an apparent rotation of the tectonic stress field to the south. Compressional features trending east-west to northwest-southeast have been mapped offshore from Cabo Rojo to Ponce (Figure 27).

A focal mechanism solution for Guayanilla indicates that deformation is occurring in response to NNE - SSW horizontal compressional stress. Reverse faulting with a large component of right-lateral movement occurs in the Guayanilla Canyon. Furthermore, multichannel seismic reflection records from the north slope (landward side) of the Muertos Trough reveal compressional structures analogous to structures in the active Pacific and eastern Caribbean trench arc systems (Ladd and Watkins, 1977, 1978; Matthews and Holcombe, 1976; Garrison, et al., 1927).

Considering the Western Puerto Rico Region as a whole, most of the active deformation seems to be localized along the NW - SE and E-W trending structures. Compressional features prevail over tensional along all the major tectonic structures of Puerto Rico.

It appears, therefore, that the island of Puerto Rico behaves like a small microplate caught in a wide transform margin between the North American and Caribbean plates. The margins involve strike - slip faulting along the Muertos Trough and Puerto Rico Trench, (Figure 37). This conclusion, based on the microseismicity of the Western Puerto Rico region, should be corroborated with the microseismicity of the eastern part of Puerto Rico and eastern Hispaniola region.

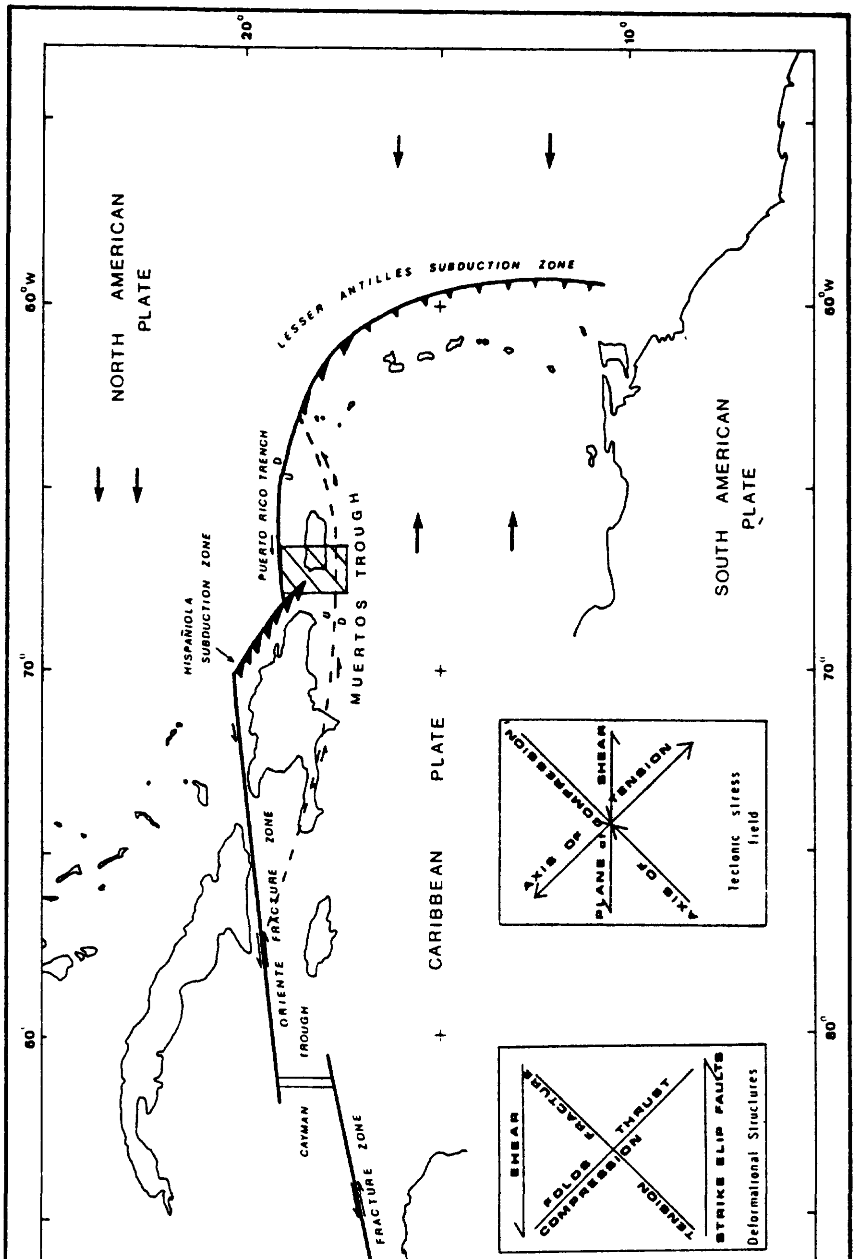


Figure 37: Proposed tectonic model for the Northeastern Caribbean Plate.

CONCLUSIONS

The accurate location of 268 small earthquakes recorded during a one year period in the western part of Puerto Rico indicates that:

1. The combination of shallow events in the Puerto Rico Trench and intermediate to depth focus events (up to a maximum depth of 155 km) under the island defines a seismic dipping zone under Puerto Rico. Shallow crustal seismicity range in depth from near surface to a maximum depth of about 30 km.

2. Active deformation is occurring along well defined surface and/or near surface geologic structures.
3. A composite focal mechanism solution for the Mayaguez Fault, which may be an extension of the Great Southern Fault, suggests that deformation is occurring in response to active ENE-WSW (N75^{o}E), directed horizontal compressional stresses.
4. An apparent rotation of the stress field appears to occur in the Guayanilla Canyon. The fault plane solution suggests that deformation is occurring in response to active NNE - SSW directed horizontal compressional stresses.

5. Most of the earthquake activity north of the Great Southern Puerto Rico Fault Zone is intermediate to deep focus, probably associated with the south-dipping Benioff Zone.
6. It is suggested, that the island of Puerto Rico behaves like a small microplate caught in a wide transform margin between the North American and Caribbean plates. The margins involve strike-slip faulting along the Muertos Trough and Puerto Rico Trench.
7. Crustal models derived from the study of refracted arrivals from earthquakes lying outside the network and modeling the structure using arrival times from local earthquakes corroborate an earlier model determined by Talwani et al., (1959) using seismic refraction and gravity data. The model consists of two layers (v_1 = 5.5 km/sec., v_2 = 7.0 km/sec.) over an half-space velocity of 8.2 km/sec.
8. Magnitudes were determined using the signal duration method. A b value of approximately 0.74 was determined for earthquakes within the western Puerto Rico region. The

relationship differ slightly within the island block itself and the offshore region; *b* values of 0.67 and 0.70 were determined for the former and latter region respectively.

APPENDIX

A. Catalog of Regional Seismicity (1820-1977)

B. Earthquake History of Western Puerto Rico

C. Catalog of Western Puerto Rico Microseismicity

Appendix A --Catalog of Regional Seismicity

Catalog		Origin time (UTC)						North latitude	East longitude	Focal depth	No		Hypo	Magnitude								Intensity		Felt
Name	Index	Yr	Mo	D	H	Min	S	(deg)	(deg)	(km)	ev	Q	auth	mb	Auth	MS	Auth	ML	Auth	Oth	Auth	K.M.	Auth	area *
or-re	1	1824	4	20	..	..	......Z	18.400	-64.900	.....	..	.	EQH	...	....	...	....	...	....	...	....	7.0D	....	....
	2	1843	2	8	15	40	......Z	16.000	-62.000	.....	..	.	EQH	...	....	...	....	...	....	...	....	....F	....	....
	3	1865	5	12	..	..	......Z	18.400	-64.900	.....	..	.	EQH	...	....	...	....	...	....	...	....	6.0D	....	....
	4	1867	11	18	18	45	......Z	18.200	-65.000	.....	..	.	EQH	...	....	...	....	...	....	...	....	8.0D	....	....
	5	1875	12	8	..	..	......Z	18.500	-66.700	.....	..	.	EQH	...	....	...	....	...	....	...	....	7.0D	....	....
	6	1906	9	27	..	..	X	19.000	-66.500	.....	..	.	EQH	...	....	...	....	...	....	...	....	7.0D	....	....
	7	1911	10	6	10	16	12.000	19.000	-70.500	.....	..	.	G-R	...	....	...	....	...	....	7.0	PAS	....	....	....
	8	1915	10	11	19	33	12.000	19.000	-67.000	.....	..	.	G-R	...	....	...	....	...	....	6.8	PAS	....	....	....
	9	1916	4	24	4	26	42.000	18.500	-68.000	80.0	..	.	G-R	...	....	...	....	...	....	7.2	PAS	8.0D	....	....
	10	1916	11	30	13	18	......	20.000	-70.000	.....	..	.	G-R	...	....	...	....	...	....	6.8	PAS	....	....	....
	11	1917	7	27	1	1	......Z	19.000	-67.500	.....	..	.	EQH	...	....	...	....	...	....	7.0	....	5.0F	....	....
	12	1918	6	11	12	36	30.000	19.000	-62.500	.....	..	.	G-R	...	....	...	....	...	....	5.8	PAS	....	....	....
	13	1918	10	11	14	14	30.000	18.500	-67.500	.....	..	.	G-R	...	....	...	....	...	....	7.5	PAS	9.0C	....	....
	14	1919	9	6	9	29	49.000	19.500	-64.500	.....	..	.	G-R	...	....	...	....	...	....	6.3	PAS	....	....	....
	15	1920	2	10	22	7	15.000	18.000	-67.500	.....	..	.	G-R	...	....	...	....	...	....	6.5	PAS	....	....	....
	16	1922	12	18	12	35	3.000	19.000	-67.000	.....	..	.	G-R	...	....	...	....	...	....	6.3	PAS	....	....	....
	17	1923	3	15	6	3	12.000	20.000	-68.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	18	1925	9	29	17	33	50.000	18.500	-62.000	.....	..	.	G-R	...	....	...	....	...	....	6.5	PAS	....	....	....
	19	1926	3	24	5	41	21.000	19.500	-69.500	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	20	1927	8	2	00	51	46.000	19.000	-64.500	.....	..	.	G-R	...	....	...	....	...	....	6.5	PAS	....	....	....
	21	1930	6	25	12	6	20.000	19.000	-64.000	.....	..	.	G-R	...	....	...	....	...	....	6.3	PAS	....	....	....
	22	1933	7	21	7	29	5.000	19.000	-68.500	100.0	..	.	G-R	...	....	...	....	...	....	5.8	PAS	....	....	....
	23	1935	9	15	4	1	35.000	19.000	-65.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	24	1935	11	10	18	27	46.000	16.500	-62.500	100.0	..	.	G-R	...	....	...	....	...	....	6.3	PAS	....	....	....
	25	1936	3	20	17	48	34.000	18.500	-62.000	50.0	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	26	1939	3	7	11	20	49.000	18.000	-67.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	27	1939	3	7	22	10	33.000	18.000	-67.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	28	1939	4	23	17	29	......	18.800	-69.300	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	29	1939	6	12	4	5	9.000	20.500	-66.000	.....	..	.	G-R	...	....	...	....	...	....	6.3	PAS	....	....	....
	30	1939	12	24	18	53	57.000	18.000	-68.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	31	1941	1	17	12	35	44.000	18.500	-63.500	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	32	1942	4	25	19	38	6.000	19.000	-70.500	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	33	1942	7	5	23	16	10.000	19.500	-70.000	50.0	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	34	1943	7	29	3	2	......Z	19.000	-67.200	.....	..	.	USE	...	....	...	....	...	....	...	....	5.0F	....	....
	35	1943	7	29	3	2	16.000	19.250	-67.500	25.0A	..	.	G-R	...	....	...	....	...	....	7.9	PAS	5.0F	....	....
	36	1943	7	30	1	2	30.000	19.250	-67.750	.....	..	.	G-R	...	....	...	....	...	....	6.5	PAS	....F	....	....
	37	1943	7	31	3	22	12.000	19.000	-67.100	.....	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	38	1943	8	8	00	38	43.000	19.000	-68.000	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	39	1943	8	15	00	13	15.000	19.000	-68.250	.....	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....	....	....
	40	1943	9	10	2	31	36.000	19.000	-66.800	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	41	1944	2	15	15	56	......	17.000	-67.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	42	1944	5	21	17	7	6.000	19.500	-71.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	43	1944	5	24	1	30	24.000	19.500	-71.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	44	1944	6	3	7	12	15.000	20.000	-63.000	.....	..	.	G-R	...	....	...	....	...	....	5.8	PAS	....	....	....
	45	1944	6	7	6	28	54.000	16.500	-72.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	Q	Hypo auth	mb	Auth	MS	Auth	ML	Auth	Oth	Auth	M.M.	Auth	Felt area *
pr-re	46	1944	8	9	4	15	30.000	18.500	-67.000	60.0	..	.	G-R	...	....	...	....	...	....	5.6	PAS	....F	....	....
	47	1945	1	22	7	47	53.000	19.500	-70.500	.....	..	.	G-R	...	....	...	....	...	....	6.0	PAS	....F	....	....
	48	1945	7	13	20	29	25.000	19.000	-64.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	49	1945	9	26	14	27	......	19.000	-65.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	50	1945	11	8	23	51	58.000	19.000	-68.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	51	1945	11	22	15	19	21.000	19.500	-70.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	52	1946	8	4	17	51	5.000	19.250	-69.000	.....	..	.	G-R	...	....	...	....	...	....	8.1	PAS	C	....	....
	53	1946	8	8	13	28	28.000	19.500	-69.500	25.0A	..	.	G-R	...	....	...	....	...	....	7.9	PAS	....	....	....
	54	1946	10	4	14	45	26.000	18.750	-68.500	50.0	..	.	G-R	...	....	...	....	...	....	7.0	PAS	....	....	....
	55	1948	4	21	20	22	2.000	19.250	-69.250	40.0	..	.	G-R	...	....	...	....	...	....	7.3	PAS	....F	....	....
	56	1949	2	5	20	18	22.000	19.000	-70.500	.....	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	57	1949	2	8	4	31	34.000	18.000	-68.500	100.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	58	1949	2	15	14	9	......	19.000	-70.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	59	1949	2	18	9	1	35.000	19.500	-70.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	60	1949	3	23	9	30	6.000	19.000	-68.500	60.0	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	61	1949	6	4	23	26	30.000	19.500	-67.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	62	1949	6	12	4	31	36.000	19.000	-69.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	63	1949	6	22	13	4	45.000	19.000	-69.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	64	1949	12	21	12	31	19.000	18.500	-67.000	100.0	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	65	1950	1	2	00	42	26.000	19.000	-67.500	37.0	..	.	USE	...	....	...	....	...	....	4.7	PAL	....F	....	....
	66	1950	1	24	5	52	5.000	18.000	-63.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	67	1950	6	15	17	57	45.000	19.000	-69.000	100.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	68	1950	7	26	8	31	29.600	19.020	-67.490	.....	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	69	1950	8	13	16	43	25.200	19.590	-70.030	43.0	..	.	SYK	...	....	...	....	...	....	4.9	PAL	....	....	....
	70	1950	8	21	15	41	1.300	19.950	-70.110	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	71	1950	10	6	8	16	3.500	19.570	-65.430	43.0	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	72	1950	10	6	11	20	13.200	17.760	-68.110	37.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	73	1950	10	6	12	43	3.000	19.500	-64.500	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	74	1950	10	19	3	48	32.800	19.360	-64.440	47.0	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	75	1950	10	20	7	44	43.100	19.330	-64.580	55.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	76	1950	11	3	6	29	48.300	16.570	-67.710	6.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	77	1950	11	7	1	27	29.200	17.050	-67.910	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	78	1950	12	4	16	21	42.400	18.320	-64.230	.....	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	79	1950	12	27	23	9	52.300	16.890	-62.440	6.0	..	.	SYK	...	....	...	....	...	....	4.6	PAL	....	....	....
	80	1950	12	27	23	19	16.100	17.020	-62.460	28.0	..	.	SYK	...	....	...	....	...	....	4.7	PAL	....	....	....
	81	1950	12	29	20	16	27.100	17.120	-62.540	43.0	..	.	SYK	...	....	...	....	...	....	4.3	PAL	....	....	....
	82	1950	12	31	9	46	28.000	17.000	-63.000	100.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	83	1951	2	10	15	12	23.800	19.310	-69.520	60.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	84	1951	2	21	17	52	49.000	18.500	-69.000	100.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	85	1951	2	21	20	40	41.000	18.570	-68.520	82.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	86	1951	4	26	20	40	24.400	17.500	-63.450	135.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	87	1951	6	29	3	49	32.300	17.010	-66.400	59.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	88	1951	7	11	23	44	15.500	18.000	-68.680	177.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	89	1951	8	20	8	55	51.900	19.320	-69.390	66.0	..	.	SYK	...	....	...	....	...	....	3.8	PAL	....	....	....
	90	1951	8	27	1	32	50.200	17.880	-71.040	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	Q	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area *
pr-re	91	1951	9	15	0	11	23.200	18.330	-65.700	96.0	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....
	92	1951	9	21	4	22	11.800	19.490	-70.190	52.0	..	.	SYK	...	....	...	....	...	....	4.3	PAL	....	....	....
	93	1951	9	27	13	52	21.500	17.700	-63.050	112.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	94	1951	10	3	2	00	48.600	17.710	-62.150	32.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	95	1952	1	6	15	48	0.800	18.510	-71.640	.....	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....
	96	1952	2	2	12	24	8.600	17.790	-66.610	116.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	97	1952	8	20	8	31	3.100	18.950	-67.140	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	98	1952	8	27	17	1	......	18.500	-66.500	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	99	1952	8	27	17	1	3.800	19.090	-66.580	52.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....F	....	....
	100	1952	10	2	12	24	45.200	16.870	-66.110	44.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	101	1952	11	21	4	14	53.100	19.300	-62.760	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	102	1952	11	21	6	10	33.700	19.330	-67.900	.....	..	.	SYK	...	....	...	....	...	....	4.3	PAL	....	....	....
	103	1952	11	21	7	6	6.000	19.170	-62.720	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	104	1952	11	21	13	40	1.800	18.880	-63.230	.....	..	.	SYK	...	....	...	....	...	....	4.5	PAL	....	....	....
	105	1952	12	5	00	54	6.400	19.730	-69.930	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	106	1952	12	11	1	33	50.400	19.250	-69.680	81.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	107	1952	12	14	10	38	39.800	19.000	-68.990	.....	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	108	1953	2	21	22	17	46.400	18.200	-66.220	120.0	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....
	109	1953	5	31	19	58	35.000	20.000	-70.500	33.0	..	.	CGS	...	....	...	....	...	....	6.8	PAS	5.0F	....	....
	110	1953	5	31	20	56	21.000	19.400	-70.400	33.0	..	.	ISS	...	....	...	....	...	....	...	....	....	....	....
	111	1953	6	1	4	15	46.500	19.590	-69.990	38.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	112	1953	6	1	4	49	1.400	19.780	-70.130	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	113	1953	6	1	20	33	33.800	19.770	-70.270	.....	..	.	SYK	...	....	...	....	...	....	3.7	PAL	....	....	....
	114	1953	6	2	8	7	30.000	20.000	-70.500	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	115	1953	6	2	14	6	0.300	19.940	-70.150	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	116	1953	6	2	22	15	54.000	19.640	-70.150	.....	..	.	SYK	...	....	...	....	...	....	4.5	PAL	....F	....	....
	117	1953	6	5	18	15	50.100	19.710	-70.470	.....	..	.	SYK	...	....	...	....	...	....	3.7	PAL	....	....	....
	118	1953	6	7	12	23	59.400	19.910	-70.060	16.0	..	.	SYK	...	....	...	....	...	....	5.5	PAL	....F	....	....
	119	1953	6	11	17	46	8.000	20.010	-69.940	.....	..	.	SYK	...	....	...	....	...	....	3.7	PAL	....	....	....
	120	1953	6	15	14	24	7.700	19.160	-67.320	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	121	1953	6	23	8	39	27.500	20.270	-70.070	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	122	1953	7	26	15	26	32.500	19.970	-70.060	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	123	1953	8	21	13	31	37.700	19.040	-67.650	.....	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	124	1953	10	14	00	51	40.700	19.500	-70.280	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	125	1953	10	19	18	25	15.400	19.560	-65.570	.....	..	.	SYK	...	....	...	....	...	....	4.6	PAL	....	....	....
	126	1953	10	20	10	30	11.100	19.760	-70.110	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	127	1953	12	25	2	19	34.900	18.440	-62.020	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	128	1953	12	25	2	25	29.000	17.500	-62.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	129	1954	2	9	8	56	38.400	19.120	-65.150	68.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	130	1954	2	11	14	33	51.000	19.000	-63.000	.....	..	.	BCI	...	....	...	....	...	....	...	....	....	....	....
	131	1954	2	12	3	13	48.000	17.310	-67.870	231.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	132	1954	3	3	18	35	53.600	18.290	-68.050	47.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	133	1954	3	9	21	36	6.500	19.690	-70.330	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	134	1954	4	1	2	22	11.300	18.780	-64.790	.....	..	.	SYK	...	....	...	....	...	....	3.8	PAL	....	....	....
	135	1954	4	1	14	8	56.900	19.380	-67.230	8.0	..	.	SYK	...	....	...	....	...	....	4.8	PAL	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	G	Hypo auth	mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area *
pr-re	136	1954	4	7	21	25	0.200	19.630	-66.000	9.0	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	137	1954	4	25	9	56	27.900	19.500	-69.280	.....	..	.	SYK	...	....	...	....	...	....	3.5	PAL	....	....	....
	138	1954	7	22	22	29	9.400	20.000	-70.010	66.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	139	1954	8	11	11	12	39.400	18.750	-69.280	126.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	140	1954	8	17	16	45	34.100	17.290	-63.020	160.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	141	1954	9	25	19	22	24.900	19.740	-69.610	68.0	..	.	SYK	...	....	...	....	...	....	3.7	PAL	....	....	....
	142	1954	9	29	21	44	57.000	18.220	-68.190	133.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	143	1954	11	8	2	15	26.500	19.770	-71.240	13.0	..	.	SYK	...	....	...	....	...	....	3.8	PAL	....	....	....
	144	1954	12	4	18	10	24.200	19.560	-69.410	1.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	145	1955	2	17	19	57	5.200	19.280	-65.230	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	146	1955	2	18	8	6	43.200	19.020	-68.080	74.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	147	1955	3	13	23	32	1.200	18.970	-64.170	18.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	148	1955	3	25	5	58	8.200	19.160	-65.300	44.0	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....
	149	1955	3	29	17	46	47.100	17.480	-62.150	181.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	150	1955	5	13	3	29	49.000	19.000	-63.500	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	151	1955	5	13	3	29	56.100	19.280	-64.380	.....	..	.	SYK	...	....	...	....	...	....	5.8	PAL	....F	....	....
	152	1955	5	13	5	21	19.900	19.070	-64.380	46.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	153	1955	5	13	6	59	31.700	18.730	-64.000	18.0	..	.	SYK	...	....	...	....	...	....	3.8	PAL	....	....	....
	154	1955	5	30	00	23	16.900	18.920	-63.310	.....	..	.	SYK	...	....	...	....	...	....	4.0	PAL	....	....	....
	155	1955	8	19	14	36	21.400	19.290	-64.610	41.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	156	1955	9	3	5	23	15.400	19.460	-69.440	54.0	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	157	1955	12	21	11	58	32.900	18.090	-67.880	22.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	158	1956	2	13	15	33	14.000	19.000	-66.500	.....	..	.	USE	...	....	...	....	...	....	...	....	5.0F	....	....
	159	1956	2	13	15	33	16.400	18.930	-66.300	50.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....F	....	....
	160	1956	3	13	1	40	34.100	19.990	-70.080	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	161	1956	3	21	7	43	56.100	19.410	-64.540	45.0	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	162	1956	3	23	4	3	8.100	19.860	-64.200	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	163	1956	3	26	3	59	2.200	19.390	-64.460	.....	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	164	1956	3	31	1	34	......	20.000	-64.000	19.0	..	.	CGS	...	....	...	....	...	....	4.2	PAL	....	....	....
	165	1956	8	1	20	28	31.800	19.040	-71.040	28.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....	....	....
	166	1956	8	4	11	22	35.800	18.800	-67.250	46.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	167	1956	12	2	1	45	53.400	18.270	-68.370	62.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	168	1957	10	23	4	38	30.080	19.000	-64.000	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	169	1957	10	23	4	38	36.300	18.810	-64.330	33.0	..	.	SYK	...	....	...	....	...	....	4.2	PAL	....F	....	....
	170	1958	1	26	2	10	55.700	17.590	-62.990	106.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	171	1958	2	1	13	32	36.400	18.900	-68.420	194.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	172	1958	3	15	20	46	23.000	18.000	-64.000	.....	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	173	1958	3	25	18	42	27.000	18.000	-64.500	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	174	1958	3	25	18	42	32.600	17.990	-64.900	36.0	..	.	SYK	...	....	...	....	...	....	4.3	PAL	....F	....	....
	175	1958	5	16	20	21	18.700	18.130	-68.210	64.0	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....F	....	....
	176	1958	5	21	14	8	18.500	17.460	-62.880	117.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	177	1958	9	25	7	55	32.100	19.060	-66.170	42.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	178	1958	11	1	8	38	42.000*	18.000	-67.500	.....	..	.	BCI	...	....	...	....	...	....	...	....	....	....	....
	179	1959	1	27	00	20	24.700	18.030	-68.630	94.0	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....
	180	1959	3	13	15	33	39.400	18.260	-71.740	47.0	..	.	SYK	...	....	...	....	...	....	...	....	....F	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	Q	Hypo auth	mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area *
pr-re	181	1959	3	27	7	2	9.200	17.230	-63.040	153.0	..	.	SYK	...	....	...	....	...	....	...	....	2.0F	....	....
	182	1959	3	29	5	39	58.000	19.000	-64.500	.....	..	.	USE	...	....	...	....	...	....	...	....	5.0F	....	....
	183	1959	3	29	5	40	9.800	18.430	-65.590	70.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....F	....	....
	184	1959	4	25	6	6	3.300	19.590	-65.750	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....F	....	....
	185	1959	4	25	6	6	4.000	19.500	-66.000	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	186	1959	5	3	5	11	48.000*	17.000	-62.000	.....	..	.	HCI	...	....	...	....	...	....	...	....	....	....	....
	187	1959	5	15	18	37	51.500	19.600	-63.570	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	188	1959	5	24	00	9	26.200	18.900	-64.350	.....	..	.	SYK	...	....	...	....	...	....	3.8	PAL	....F	....	....
	189	1959	5	24	00	9	29.000	19.500	-64.500	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	190	1959	5	27	4	12	37.000	19.400	-65.200	64.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	191	1959	7	1	1	13	2.000	18.720	-64.520	25.0	..	.	SYK	...	....	...	....	...	....	3.6	PAL	....F	....	....
	192	1959	7	21	9	17	56.100	18.870	-68.040	55.0	..	.	SYK	...	....	...	....	...	....	5.3	PAL	....F	....	....
	193	1959	8	1	15	40	27.300	20.000	-67.360	.....	..	.	SYK	...	....	...	....	...	....	3.5	PAL	....	....	....
	194	1959	8	2	20	29	59.800	19.590	-67.690	12.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	195	1959	8	11	8	9	3.600	19.200	-64.800	.....	..	.	SYK	...	....	...	....	...	....	3.7	PAL	....	....	....
	196	1959	9	1	10	49	45.300	19.930	-65.150	.....	..	.	SYK	...	....	...	....	...	....	4.7	PAL	....	....	....
	197	1959	9	1	11	46	57.700	19.500	-65.640	90.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	198	1959	9	2	9	31	37.600	20.020	-65.020	.....	..	.	SYK	...	....	...	....	...	....	3.9	PAL	....	....	....
	199	1959	11	24	3	5	17.200	19.360	-64.790	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	200	1959	12	19	13	46	21.900	19.580	-71.580	24.0	..	.	SYK	...	....	...	....	...	....	4.1	PAL	....	....	....
	201	1960	1	19	6	7	27.600	19.950	-71.470	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	202	1960	1	23	2	29	57.200	17.460	-65.740	.....	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	203	1960	3	11	4	42	50.000	18.270	-68.620	68.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	204	1960	5	31	11	2	20.000	18.000	-62.000	.....	..	.	CGS	...	....	...	....	...	....	6.6	PAS	5.0F	....	....
	205	1960	9	14	1	53	21.300	19.660	-70.170	.....	..	.	SYK	...	....	...	....	...	....	4.4	PAL	....	....	....
	206	1960	10	20	5	33	5.300	17.600	-62.400	91.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	207	1960	11	15	2	18	14.900	18.440	-68.310	150.0	..	.	SYK	...	....	...	....	...	....	...	....	....	....	....
	208	1961	4	12	10	42	40.500	18.700	-67.400	33.0N	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	209	1961	6	1	10	2	42.000	19.300	-69.300	21.0	..	.	CGS	...	....	...	....	...	....	4.4	PAL	....	....	....
	210	1961	8	3	3	8	5.100	18.400	-66.300	132.0	..	.	CGS	...	....	...	....	...	....	...	....	5.0F	....	....
	211	1961	8	19	14	52	29.700	18.000	-68.800	100.0	..	.	CGS	...	....	...	....	...	....	5.5	BRK	....F	....	....
	212	1961	8	29	17	12	53.000	19.400	-68.700	33.0N	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	213	1961	10	12	13	53	34.400	19.200	-64.900	40.0	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	214	1961	11	2	23	3	55.600	17.200	-62.700	29.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	215	1961	11	7	23	40	4.000	17.100	-62.600	33.0N	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	216	1961	11	16	8	19	54.100	18.500	-68.800	152.0	..	.	CGS	...	....	...	....	...	....	6.0	PAS	....	....	....
	217	1961	12	4	7	36	23.100	18.600	-69.000	140.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	218	1962	1	8	1	00	22.700	18.400	-70.400	32.0	..	.	CGS	...	....	...	....	...	....	6.5	PAS	C	....	....
	219	1962	1	8	1	34	50.700	18.000	-70.600	48.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	220	1962	1	8	2	5	21.100	18.500	-70.600	50.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	221	1962	1	9	2	9	51.200	18.600	-70.600	25.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	222	1962	2	10	19	31	55.700	17.900	-62.200	71.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	223	1962	2	27	8	42	56.000	19.300	-67.700	32.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	224	1962	2	28	20	34	21.100	19.200	-69.300	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	225	1962	5	20	15	1	20.700	20.500	-66.000	38.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	Q	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area *
pr-re	226	1962	6	7	15	00	2.000	17.200	-62.000	76.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	227	1962	6	14	8	30	51.400	19.300	-64.900	57.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	228	1962	7	23	22	11	54.600	19.000	-65.100	25.0	..	.	CGS	...	....	...	....	...	....	...	....	....F	....	....
	229	1962	10	24	1	50	7.000	19.100	-67.100	45.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	230	1962	11	6	15	8	4.200	16.900	-68.500	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	231	1963	2	22	21	14	2.300	18.100	-71.400	17.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	232	1963	3	13	10	39	20.100	19.500	-69.500	49.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	233	1963	3	22	1	44	26.300	19.300	-66.900	51.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	234	1963	5	23	7	43	56.900	19.200	-64.500	47.0	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....
	235	1963	6	18	13	9	34.600	18.300	-71.000	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	236	1963	6	18	16	54	1.100	19.600	-65.700	4.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	237	1963	10	8	2	59	55.900	19.500	-65.600	33.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	238	1963	10	16	22	21	15.800	17.700	-62.000	67.0	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....
	239	1963	10	23	20	4	6.700	16.600	-62.200	33.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	240	1963	11	15	18	16	45.000	20.100	-70.000	50.0	..	.	CGS	3.7	....	...	....	...	....	...	....	....	....	....
	241	1963	11	28	2	44	36.300	19.100	-69.400	48.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	242	1963	11	28	3	18	59.700	19.100	-69.500	33.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	243	1964	1	18	22	36	17.600	18.800	-69.400	95.0	..	.	CGS	5.3	....	...	....	...	....	...	....	....	....	....
	244	1964	2	1	22	53	15.000	19.400	-66.300	37.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	245	1964	3	2	10	55	44.200	17.800	-67.100	33.0	..	.	CGS	3.6	....	...	....	...	....	...	....	....	....	....
	246	1964	3	16	20	40	47.900	19.500	-65.300	33.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	247	1964	3	24	8	28	10.400	19.200	-65.900	58.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	248	1964	4	7	10	41	29.300	17.900	-68.000	98.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	249	1964	4	25	21	29	30.400	19.800	-71.200	35.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	250	1964	5	28	1	27	49.000	19.600	-70.200	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	251	1964	5	31	10	30	25.000	19.200	-69.400	83.0	..	.	CGS	5.0	....	...	....	...	....	...	....	....	....	....
	252	1964	6	16	19	54	46.500	19.600	-66.800	30.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	253	1964	7	14	9	55	24.400	19.000	-66.500	46.0	..	.	CGS	4.8	....	...	....	...	....	4.4	PAL	....F	....	....
	254	1964	8	3	1	48	23.300	19.800	-70.700	7.0	..	.	CGS	5.2	....	...	....	...	....	...	....	....	....	....
	255	1964	8	10	1	10	12.400	19.100	-67.300	33.0	..	.	CGS	5.5	....	...	....	...	....	...	....	....	....	....
	256	1964	8	24	8	31	5.800	18.400	-68.800	179.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	257	1964	8	25	22	27	18.500	18.200	-68.200	96.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	258	1964	10	9	11	27	57.000	18.400	-68.900	178.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	259	1964	10	18	7	7	31.800	19.400	-68.700	33.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	260	1964	11	5	8	47	6.000	18.200	-68.400	183.0	..	.	CGS	4.8	....	...	....	...	....	...	....	....	....	....
	261	1964	11	28	19	35	47.800	19.000	-64.600	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	262	1964	11	30	9	46	56.100	18.300	-69.300	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....
	263	1964	12	8	20	55	55.300	19.000	-64.000	55.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	264	1964	12	22	8	1	12.600	18.400	-68.800	115.0	..	.	CGS	5.6	....	...	....	...	....	6.0	PAS	....F	....	....
	265	1965	1	1	10	2	49.800	19.600	-68.500	33.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	266	1965	1	10	0	18	17.600	18.500	-68.300	143.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....
	267	1965	5	11	8	6	44.200	19.100	-65.200	68.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....
	268	1965	5	13	00	8	16.600	19.600	-65.400	30.0	..	.	CGS	4.7	....	...	....	...	....	4.4	PAL	....	....	....
	269	1965	5	17	7	26	21.300	18.200	-67.800	69.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	270	1965	5	21	7	23	29.300	19.700	-71.600	33.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Catalog Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	U	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area	*
pr-re	271	1965	5	27	16	52	45.300	18.800	-64.300	42.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	272	1965	6	3	10	57	8.500	18.500	-70.300	27.0	..	.	CGS	5.3	....	...	....	...	....	5.1	BRK	....F	....	....	
	273	1965	6	10	20	53	41.500	18.900	-70.100	63.0	..	.	CGS	3.7	....	...	....	...	....	...	....	....	....	....	
	274	1965	6	12	10	49	14.400	18.500	-65.800	108.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	275	1965	6	12	10	59	16.900	19.200	-64.900	25.0	..	.	CGS	5.4	....	...	....	...	....	...	....	....	....	....	
	276	1965	6	12	14	27	29.900	19.300	-65.000	33.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	277	1965	6	16	14	12	39.800	18.100	-68.700	116.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	278	1965	6	30	9	59	34.900	18.500	-68.700	122.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	279	1965	7	9	17	32	24.700	19.400	-66.500	33.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	280	1965	7	25	19	52	43.000	18.200	-68.100	77.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	281	1965	9	6	4	59	41.500	18.600	-67.600	33.0	..	.	CGS	5.7	....	...	....	...	....	...	....	....	....	....	
	282	1965	11	7	4	43	51.100	18.600	-71.800	35.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....	
	283	1965	11	15	19	22	5.000	18.600	-67.500	22.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	284	1965	11	16	4	8	4.700	18.700	-67.500	33.0	..	.	CGS	3.8	....	...	....	...	....	...	....	....	....	....	
	285	1965	11	21	23	3	13.200	19.300	-67.400	21.0	..	.	CGS	5.1	....	...	....	...	....	...	....	....	....	....	
	286	1965	12	10	3	46	4.300	18.500	-69.000	145.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	287	1966	1	13	10	30	51.800	19.000	-64.700	50.0	..	.	CGS	5.3	....	...	....	...	....	4.6	PAL	....	....	....	
	288	1966	1	14	8	52	18.100	17.800	-62.100	42.0	..	.	CGS	5.6	....	...	....	...	....	...	....	....	....	....	
	289	1966	1	14	10	2	7.400	16.800	-62.400	23.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....	
	290	1966	1	15	6	35	58.000	19.300	-65.300	33.0	..	.	CGS	5.4	....	...	....	...	....	...	....	....	....	....	
	291	1966	2	11	6	36	12.400	19.100	-64.400	14.0	..	.	CGS	3.8	....	...	....	...	....	...	....	....	....	....	
	292	1966	4	1	1	37	28.100	18.600	-69.300	140.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	293	1966	4	16	7	12	36.700	18.300	-62.000	28.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	294	1966	4	16	11	31	59.200	19.000	-70.500	27.0	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....	
	295	1966	4	21	12	41	0.700	19.000	-64.700	57.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	296	1966	5	2	23	39	7.600	19.000	-69.300	142.0	..	.	CGS	3.7	....	...	....	...	....	...	....	....	....	....	
	297	1966	5	8	4	48	38.500	17.100	-70.100	33.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....	
	298	1966	6	10	5	34	18.900	19.900	-70.400	11.0	..	.	CGS	3.8	....	...	....	...	....	...	....	....	....	....	
	299	1966	6	17	1	14	2.200	18.500	-68.800	110.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	300	1966	6	20	6	8	20.600	18.000	-68.500	60.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	301	1966	7	12	12	40	22.400	18.200	-62.500	33.0	..	.	CGS	...	....	...	....	...	....	...	....	....	....	....	
	302	1966	7	16	20	9	52.000	18.200	-64.700	135.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	303	1966	8	28	19	35	56.600	19.800	-64.200	60.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	304	1966	9	10	21	58	46.700	19.300	-67.900	26.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	305	1966	10	14	1	49	28.500	19.200	-67.800	47.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	306	1966	10	31	5	11	58.400	19.400	-67.700	20.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....	
	307	1966	10	31	6	46	41.600	19.500	-67.700	33.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....	
	308	1966	10	31	18	23	51.600	19.200	-67.800	34.0	..	.	CGS	4.8	....	...	....	...	....	...	....	....	....	....	
	309	1966	11	3	11	37	21.900	19.100	-67.900	37.0	..	.	CGS	5.2	....	...	....	...	....	...	....	....	....	....	
	310	1966	11	3	16	24	32.700	19.200	-68.000	33.0	..	.	CGS	5.6	....	...	....	...	....	...	....	....	....	....	
	311	1966	11	3	17	26	6.000	19.300	-67.900	19.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	312	1966	11	4	10	52	57.400	19.200	-67.800	33.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	313	1966	11	9	20	37	18.000	19.400	-67.800	33.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	314	1966	11	9	21	55	37.600	19.200	-67.900	18.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	315	1966	11	12	00	44	20.600	19.600	-64.400	30.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	

Appendix A --Catalog of Regional Seismicity--Continued

Catalog		Origin time (UTC)						North	East	Focal				Magnitude								Intensity			
								latitude	longitude	depth	No		Hypo												Felt
Name	Index	Yr	Mo	D	H	Min	S	(deg)	(deg)	(km)	ev	Q	auth	mb	Auth	MS	Auth	ML	Auth	Oth	Auth	M.M.	Auth	area	*
pr-re	316	1966	11	13	2	51	52.700	17.100	-62.000	85.0	..	.	CGS	5.6	....	...	....	...	....	...	....	....	....	....	
	317	1966	11	19	00	30	32.700	19.500	-64.300	38.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....	
	318	1966	11	20	7	25	56.400	18.200	-68.400	96.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	319	1966	11	22	12	14	7.700	19.200	-67.900	22.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	320	1966	11	25	3	31	51.500	19.500	-67.500	33.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	321	1966	11	29	00	53	2.000	18.200	-64.600	152.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	322	1966	12	7	23	54	35.600	18.300	-68.500	139.0	..	.	CGS	5.0	....	...	....	...	....	...	....	....	....	....	
	323	1967	2	18	12	51	23.400	19.253	-67.813	27.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....	
	324	1967	2	21	4	16	21.700	19.145	-67.917	49.0	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....	
	325	1967	2	21	6	29	39.300*	19.256	-67.941	29.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	
	326	1967	3	9	18	32	49.100*	19.175	-65.164	73.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	
	327	1967	3	12	5	19	0.300*	18.989	-65.115	33.0N	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	328	1967	3	16	22	59	9.200*	19.542	-69.968	33.0N	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	329	1967	4	5	3	52	57.100	19.153	-64.712	35.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	330	1967	4	6	3	7	11.800	19.588	-64.567	49.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	331	1967	4	10	12	4	32.600	18.520	-62.589	44.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	
	332	1967	4	10	20	55	21.000	19.314	-63.650	33.0N	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....	
	333	1967	4	11	1	10	10.400	19.029	-63.003	51.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....	
	334	1967	4	11	2	30	28.300	18.652	-63.324	88.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....	
	335	1967	4	11	12	42	43.800	18.961	-62.528	16.0	..	.	CGS	5.2	....	...	....	...	....	...	....	....	....	....	
	336	1967	4	12	4	40	53.700	19.348	-63.702	35.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	337	1967	4	12	19	1	1.500*	19.203	-63.544	33.0N	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	
	338	1967	4	19	21	57	4.500	18.668	-69.685	103.0D	..	.	CGS	5.1	....	...	....	...	....	...	....	....	....	....	
	339	1967	5	6	14	00	39.300	19.258	-69.964	23.0D	..	.	CGS	5.3	....	...	....	...	....	...	....	....	....	....	
	340	1967	5	11	13	54	0.200*	19.314	-69.745	33.0N	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	341	1967	5	13	18	36	13.900	18.510	-69.786	103.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	
	342	1967	5	17	11	19	35.000	19.635	-69.874	18.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....	
	343	1967	5	22	6	23	29.400	20.285	-65.906	33.0N	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....	
	344	1967	5	24	2	10	30.200*	17.984	-62.311	65.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	345	1967	6	16	6	47	37.200	19.500	-66.100	47.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....	
	346	1967	8	15	3	23	52.300	19.200	-68.500	39.0	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....	
	347	1967	8	18	21	45	20.000	19.000	-64.800	33.0	..	.	USE	4.3	....	...	....	...	....	...	....	....F	....	....	
	348	1967	9	20	22	5	3.700	19.100	-62.600	33.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	349	1967	9	21	3	19	6.100	19.000	-62.500	33.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....	
	350	1967	10	4	1	53	19.700	19.300	-70.000	19.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....	
	351	1967	11	6	18	11	50.500	18.500	-70.100	33.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	352	1967	11	28	3	21	31.400	18.400	-62.400	45.0	..	.	CGS	5.0	....	...	....	...	....	...	....	....	....	....	
	353	1967	11	29	1	23	34.500	18.400	-62.400	58.0	..	.	CGS	5.1	....	...	....	...	....	...	....	....	....	....	
	354	1967	12	24	22	23	6.200	19.400	-66.100	33.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....	
	355	1967	12	28	1	46	25.900	19.100	-67.400	33.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....	
	356	1968	2	28	15	4	38.900	19.200	-67.900	43.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....	
	357	1968	3	29	20	32	1.200	18.800	-64.800	60.0	..	.	USE	4.7	....	...	....	...	....	...	....	4.0F	....	....	
	358	1968	4	13	1	15	32.300	19.000	-66.900	51.0	..	.	USE	5.1	....	...	....	...	....	...	....	4.0F	....	....	
	359	1968	4	15	1	50	33.000	18.700	-64.800	65.0	..	.	USE	3.8	....	...	....	...	....	...	....	....F	....	....	
	360	1968	4	26	1	23	42.100	18.200	-68.000	95.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....	

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	u	hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Intensity Auth	M.M.	Auth	Felt area *
pr-re	361	1968	5	2	5	29	38.200	18.800	-69.600	.....D	..	.	USE	5.8	....	...	....	...	....	...	....	....F	....	....
	362	1968	5	10	7	21	18.000	19.019	-66.746	56.0	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....
	363	1968	6	8	7	29	57.200	18.210	-67.565	159.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....F	....	....
	364	1968	7	24	8	22	28.560	19.706	-70.103	27.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	365	1968	9	1	19	6	55.800	18.022	-67.975	129.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	366	1968	10	9	13	28	22.900	18.872	-69.786	143.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	367	1968	10	16	1	55	32.700	19.152	-69.838	36.0	..	.	CGS	5.2	....	...	....	...	....	...	....	....	....	....
	368	1968	10	31	14	30	59.300	17.924	-67.604	46.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	369	1968	11	2	12	40	2.700*	19.455	-67.742	33.0N	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	370	1968	11	2	14	31	5.000*	19.399	-67.563	62.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	371	1968	11	17	13	31	54.200	19.106	-68.056	33.0N	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	372	1968	12	2	16	23	58.500	19.266	-64.481	33.0N	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	373	1969	1	3	5	14	26.400	18.500	-65.062	113.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	374	1969	1	8	7	22	45.500*	18.237	-70.839	41.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	375	1969	1	28	12	46	54.000	19.400	-66.300	.....	..	.	USE	...	....	...	....	...	....	4.4	....	....F	....	....
	376	1969	1	28	13	46	54.000	19.376	-66.258	33.0N	..	.	CGS	4.4	....	...	....	...	....	...	....	....F	....	....
	377	1969	1	29	11	6	23.100	19.500	-66.200	.....	..	.	USE	...	....	...	....	...	....	...	....	....F	....	....
	378	1969	1	29	12	6	23.100	19.455	-66.168	33.0N	..	.	CGS	4.3	....	...	....	...	....	...	....	....F	....	....
	379	1969	2	2	9	57	31.100*	19.454	-65.131	33.0N	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	380	1969	2	15	11	17	9.600	19.744	-71.374	33.0N	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	381	1969	4	6	4	45	44.000	19.408	-64.578	33.0N	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	382	1969	6	14	1	11	35.400	20.001	-64.322	33.0N	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....
	383	1969	6	17	5	32	57.200	18.995	-66.523	54.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	384	1969	6	20	3	00	23.500	20.011	-64.199	33.0N	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	385	1969	6	20	17	40	36.300	19.880	-64.392	51.0	..	.	CGS	4.5	....	...	....	...	....	...	....	....	....	....
	386	1969	6	21	22	33	24.700	19.847	-64.383	50.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	387	1969	6	30	18	36	24.200	20.017	-64.143	17.0	..	.	CGS	5.3	....	...	....	...	....	...	....	....	....	....
	388	1969	7	27	23	49	50.300	19.956	-64.250	33.0N	..	.	CGS	5.0	....	...	....	...	....	...	....	....	....	....
	389	1969	7	29	00	40	42.500	19.935	-64.145	32.0	..	.	CGS	5.1	....	...	....	...	....	...	....	....	....	....
	390	1969	8	1	13	6	49.100	18.800	-64.400	47.0	..	.	USE	5.0	....	...	....	...	....	...	....	....F	....	....
	391	1969	8	10	3	33	57.100	19.283	-65.257	33.0N	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	392	1969	8	11	18	48	36.800	19.930	-64.401	33.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	393	1969	8	11	20	16	35.000	20.077	-64.313	33.0N	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....
	394	1969	8	11	20	45	55.800*	19.846	-64.072	33.0N	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	395	1969	8	11	20	46	41.600	19.856	-64.328	10.0	..	.	CGS	5.0	....	...	....	...	....	...	....	....	....	....
	396	1969	8	18	13	44	27.800	19.963	-64.229	33.0N	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	397	1969	9	4	10	6	21.600*	19.867	-64.342	33.0N	..	.	CGS	3.7	....	...	....	...	....	...	....	....	....	....
	398	1969	9	21	15	58	19.000	19.979	-64.431	17.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	399	1969	10	14	5	36	19.500*	19.395	-65.633	40.0	..	.	CGS	4.1	....	...	....	...	....	...	....	....	....	....
	400	1969	10	15	3	56	6.600	19.283	-65.430	50.0	..	.	CGS	4.8	....	...	....	...	....	...	....	....	....	....
	401	1969	10	22	9	37	0.500	19.241	-65.790	64.0	..	.	CGS	4.3	....	...	....	...	....	...	....	....	....	....
	402	1969	10	27	19	37	38.500	18.420	-68.764	176.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	403	1969	10	30	21	41	55.200	18.533	-68.693	145.0	..	.	CGS	4.0	....	...	....	...	....	...	....	....	....	....
	404	1969	12	2	9	46	56.900	18.667	-63.172	35.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	405	1969	12	7	6	11	22.900	19.172	-64.593	33.0N	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	Q	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity M.M.	Auth	Felt area *
pr-re	406	1970	2	14	21	3	43.200*	19.424	-69.013	117.0	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	407	1970	2	21	6	15	39.900	18.426	-62.365	33.0N	..	.	CGS	4.9	....	...	....	...	....	...	....	....	....	....
	408	1970	3	22	10	14	34.200*	18.252	-68.656	56.0	..	.	CGS	4.2	....	...	....	...	....	...	....	....	....	....
	409	1970	4	7	13	21	13.100	18.186	-68.122	93.0	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	410	1970	4	18	6	42	0.600	18.700	-62.700	25.0G	..	.	USE	4.4	....	...	....	...	....	...	....	....F	....	....
	411	1970	4	23	15	55	33.400	18.800	-64.300	14.0	..	.	USE	4.4	....	...	....	...	....	...	....	5.0F	....	....
	412	1970	5	8	17	41	29.000	19.554	-64.723	33.0N	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	413	1970	6	13	8	43	0.600*	19.256	-65.224	52.0	..	.	CGS	4.8	....	...	....	...	....	...	....	....	....	....
	414	1970	7	5	4	19	35.100	19.091	-68.400	33.0N	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	415	1970	7	5	6	10	35.000	19.027	-68.428	33.0N	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	416	1970	7	8	4	49	10.600	18.000	-64.600	150.0	..	.	USE	5.8	....	...	....	...	....	5.1	BRK	5.0D	....	....
	417	1970	8	16	8	33	18.500	19.110	-65.065	40.0G	..	.	CGS	4.7	....	...	....	...	....	...	....	....	....	....
	418	1970	9	1	23	11	39.000*	19.422	-69.208	33.0N	..	.	CGS	3.8	....	...	....	...	....	...	....	....	....	....
	419	1970	9	2	2	40	14.000*	19.369	-65.450	33.0N	..	.	CGS	3.9	....	...	....	...	....	...	....	....	....	....
	420	1970	9	7	18	6	28.100*	19.248	-65.148	35.0	..	.	CGS	4.6	....	...	....	...	....	...	....	....	....	....
	421	1970	9	21	1	1	25.700	19.371	-64.954	45.0G	..	.	CGS	4.4	....	...	....	...	....	...	....	....	....	....
	422	1970	11	8	23	10	56.900	18.600	-64.700	66.0	..	.	USE	4.9	....	...	....	...	....	...	....	4.0F	....	....
	423	1970	11	9	7	59	9.300	19.102	-67.503	38.0	..	.	NOS	4.5	....	...	....	...	....	...	....	....	....	....
	424	1970	11	15	9	19	3.500	18.982	-66.832	50.0	..	.	NOS	4.7	....	...	....	...	....	...	....	....	....	....
	425	1970	12	3	15	54	50.400*	19.045	-64.924	57.0	..	.	NOS	4.5	....	...	....	...	....	...	....	....	....	....
	426	1970	12	21	3	5	18.800	16.718	-62.049	28.0D	..	.	NOS	4.8	....	...	....	...	....	...	....	....	....	....
	427	1971	2	2	00	56	45.500	18.196	-68.393	102.0	..	.	NOS	4.8	....	...	....	...	....	...	....	....	....	....
	428	1971	2	2	1	47	44.000	18.171	-68.441	93.0	..	.	NOS	3.8	....	...	....	...	....	...	....	....	....	....
	429	1971	2	22	6	4	17.800*	19.254	-67.934	33.0N	..	.	NOS	4.5	....	...	....	...	....	...	....	....	....	....
	430	1971	3	7	4	25	18.400*	19.374	-66.246	40.0	..	.	NOS	4.5	....	...	....	...	....	...	....	....	....	....
	431	1971	6	11	12	56	4.300	17.966	-69.778	57.0	..	.	NOS	6.1	....	...	....	...	....	6.5	PAS	C	....	....
	432	1971	6	11	16	23	36.800	18.027	-69.728	53.0	..	.	NOS	4.9	....	...	....	...	....	...	....	....	....	....
	433	1971	6	11	19	27	7.200*	18.036	-69.822	43.0	..	.	NOS	4.1	....	...	....	...	....	...	....	....	....	....
	434	1971	6	12	19	18	48.500	18.913	-64.327	43.0	..	.	NOS	5.0	....	...	....	...	....	...	....	....	....	....
	435	1971	6	12	21	00	43.700	19.431	-66.472	33.0N	..	.	NOS	4.5	....	...	....	...	....	...	....	....	....	....
	436	1971	6	13	10	14	49.900*	17.920	-69.740	54.0	..	.	NOS	4.6	....	...	....	...	....	...	....	....	....	....
	437	1971	6	15	18	51	24.600*	17.990	-69.736	61.0	..	.	NOS	4.7	....	...	....	...	....	...	....	....	....	....
	438	1971	6	26	15	47	32.800	19.020	-68.016	33.0N	..	.	NOS	5.3	....	...	....	...	....	...	....	....	....	....
	439	1971	6	27	8	31	18.900	19.070	-67.917	48.0	..	.	NOS	4.9	....	...	....	...	....	...	....	....	....	....
	440	1971	7	8	5	54	12.400	19.079	-68.032	48.0	..	.	ERL	5.0	....	...	....	...	....	...	....	....	....	....
	441	1971	7	8	14	39	56.800	19.129	-64.397	33.0N	..	.	ERL	4.6	....	...	....	...	....	...	....	....	....	....
	442	1971	7	10	9	54	41.900	19.317	-64.742	33.0N	..	.	ERL	4.3	....	...	....	...	....	...	....	....	....	....
	443	1971	7	11	14	26	59.000*	19.138	-64.589	33.0N	..	.	ERL	4.0	....	...	....	...	....	...	....	....	....	....
	444	1971	7	12	23	50	15.700*	19.604	-62.968	33.0N	..	.	ERL	4.2	....	...	....	...	....	...	....	....	....	....
	445	1971	8	21	3	55	36.300	18.336	-67.723	85.0	..	.	ERL	4.5	....	...	....	...	....	...	....	....	....	....
	446	1971	8	26	2	47	49.800	19.014	-67.732	53.0	..	.	ERL	4.8	....	...	....	...	....	...	....	....	....	....
	447	1971	8	27	6	37	53.200	19.211	-68.119	33.0N	..	.	ERL	4.7	....	...	....	...	....	...	....	....	....	....
	448	1971	9	4	6	59	10.100	19.979	-70.187	33.0N	..	.	ERL	4.7	....	...	....	...	....	...	....	....	....	....
	449	1971	9	13	4	18	1.900	17.931	-69.731	48.0	..	.	ERL	5.7	....	...	....	...	....	5.4	BRK	....F	....	....
	450	1971	9	30	20	27	58.300	18.068	-64.452	152.0	..	.	ERL	4.9	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	U	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Intensity Auth	M.M.	Auth	Felt area *
pr-re	451	1972	1	3	7	54	31.500	18.849	-67.835	55.0	..	.	ERL	4.3	....	...	....	...	....	...	....	....	....	....
	452	1972	2	2	19	5	16.800*	18.508	-66.903	92.0	..	.	ERL	4.7	....	...	....	...	....	...	....	....F	....	....
	453	1972	2	23	7	30	49.200	18.236	-68.795	73.0	..	.	ERL	4.5	....	...	....	...	....	...	....	....	....	....
	454	1972	3	7	2	41	46.600*	18.469	-71.519	33.0N	..	.	ERL	4.2	....	...	....	...	....	...	....	....	....	....
	455	1972	5	23	2	35	18.400	18.537	-66.953	38.0	..	.	ERL	4.6	....	...	....	...	....	...	....	5.0F	....	....
	456	1972	6	4	16	48	16.100	20.297	-65.518	33.0N	..	.	ERL	4.7	....	...	....	...	....	...	....	....	....	....
	457	1972	6	7	6	16	9.800*	19.282	-69.600	33.0N	..	.	ERL	4.3	....	...	....	...	....	...	....	....	....	....
	458	1972	6	29	8	31	44.900*	19.211	-64.961	41.0	..	.	ERL	4.2	....	...	....	...	....	...	....	....	....	....
	459	1972	9	3	7	13	59.300	17.766	-65.677	56.0	..	.	ERL	4.6	....	...	....	...	....	...	....	4.0F	....	....
	460	1972	9	18	5	36	53.300	19.539	-70.120	13.0	..	.	ERL	4.8	....	4.6H	....	...	....	...	....	....F	....	....
	461	1972	9	19	1	36	52.400	19.536	-70.148	33.0N	..	.	ERL	5.8	....	6.1H	....	...	....	5.7	PAS	....F	....	....
	462	1972	9	20	19	14	13.400*	19.665	-70.123	33.0N	..	.	ERL	4.9	....	...	....	...	....	...	....	....	....	....
	463	1972	9	26	3	35	49.500*	19.642	-69.972	44.0	..	.	ERL	4.6	....	...	....	...	....	...	....	....	....	....
	464	1972	9	30	20	33	23.300*	19.569	-69.878	55.0	..	.	ERL	4.3	....	...	....	...	....	...	....	....	....	....
	465	1972	11	10	18	47	15.100*	19.487	-70.093	33.0N	..	.	ERL	4.0	....	...	....	...	....	...	....	....	....	....
	466	1973	4	1	13	22	10.900	19.227	-64.289	33.0N	..	.	ERL	4.7	....	4.4H	....	...	....	...	....	....	....	....
	467	1973	4	1	18	25	44.800	19.282	-64.172	34.0	..	.	ERL	4.7	....	4.6H	....	...	....	...	....	....	....	....
	468	1973	5	4	2	35	19.200*	19.025	-64.964	54.0	..	.	ERL	4.1	....	...	....	...	....	...	....	....	....	....
	469	1973	6	2	20	7	30.500	19.581	-70.610	40.0	..	.	ERL	5.2	....	5.3H	....	...	....	...	....	....	....	....
	470	1973	7	2	18	22	10.400	17.197	-71.677	25.0	..	.	ERL	4.8	....	...	....	...	....	...	....	....	....	....
	471	1973	9	10	1	43	4.600*	18.686	-62.481	63.0	..	.	GS	4.5	....	...	....	...	....	...	....	....	....	....
	472	1973	9	22	13	40	50.300*	19.754	-67.225	44.0	..	.	GS	4.0	....	...	....	...	....	...	....	....	....	....
	473	1973	10	6	00	5	19.100*	18.945	-64.513	47.0	..	.	GS	4.3	....	...	....	...	....	...	....	....	....	....
	474	1973	10	16	00	37	16.900	19.488	-64.436	33.0N	..	.	GS	4.6	....	...	....	...	....	...	....	....	....	....
	475	1973	10	18	13	48	38.300	20.036	-62.881	33.0N	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....
	476	1973	11	2	15	14	47.100*	19.508	-69.620	30.0	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....
	477	1973	11	25	21	53	6.600	18.706	-64.583	53.0	..	.	GS	4.5	....	...	....	...	....	...	....	....	....	....
	478	1973	12	5	00	24	49.600*	17.835	-66.440	17.0	..	.	GS	3.9	....	...	....	...	....	...	....	....F	....	....
	479	1974	1	1	18	37	24.600*	19.052	-64.940	57.0	..	.	GS	4.6	....	...	....	...	....	...	....	....	....	....
	480	1974	1	17	00	55	35.200*	19.464	-65.004	33.0N	..	.	GS	4.2	....	4.0H	....	...	....	...	....	....	....	....
	481	1974	1	18	16	52	43.100	18.791	-69.370	82.0D	..	.	GS	5.3	....	...	....	...	....	...	....	....F	....	....
	482	1974	1	21	14	11	6.500	18.970	-67.994	31.0D	..	.	GS	4.4	....	4.1H	....	...	....	...	....	....	....	....
	483	1974	2	14	7	49	40.300	19.737	-69.953	7.0	..	.	GS	5.1	....	4.4H	....	...	....	...	....	....	....	....
	484	1974	2	15	11	46	23.700*	19.156	-64.157	3.0	..	.	GS	4.4	....	...	....	...	....	...	....	....	....	....
	485	1974	2	20	16	11	26.800	19.583	-70.021	18.0	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....
	486	1974	3	16	12	2	2.300	18.452	-67.051	96.0	..	.	GS	4.3	....	...	....	...	....	...	....	3.0F	....	....
	487	1974	3	18	7	57	58.600*	18.374	-68.486	137.0	..	.	GS	4.0	....	...	....	...	....	...	....	....	....	....
	488	1974	4	13	5	38	5.800	18.648	-67.495	88.0	..	.	GS	4.2	....	...	....	...	....	...	....	....	....	....
	489	1974	4	22	6	7	24.400	18.820	-70.375	112.0	..	.	GS	4.5	....	...	....	...	....	...	....	....	....	....
	490	1974	5	9	9	33	21.400	18.225	-68.360	29.0	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....
	491	1974	5	19	8	3	42.400*	19.282	-66.462	46.0	..	.	GS	4.3	....	3.6H	....	...	....	...	....	....	....	....
	492	1974	6	1	4	23	17.200	18.189	-68.030	79.0	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....
	493	1974	6	21	6	10	48.100	18.943	-66.996	46.0	..	.	GS	4.9	....	4.0H	....	...	....	...	....	....	....	....
	494	1974	7	3	7	28	35.100*	18.908	-64.691	33.0N	..	.	GS	4.2	....	...	....	...	....	...	....	....	....	....
	495	1974	7	22	11	13	45.600	19.344	-63.486	33.0N	..	.	GS	4.3	....	...	....	...	....	...	....	....	....	....

Appendix A --Catalog of Regional Seismicity--Continued

Catalog Name	Catalog Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	No ev	W	Hypo auth	Magnitude mb	Auth	MS	Auth	ML	Auth	Oth	Auth	Intensity F.M.	Auth	Felt area	*
pr-re	496	1974	6	23	23	55	36.800	19.055	-68.040	33.0N	..	.	GS	5.0	....	4.3H	....	...	....	...	....	....	....	....	
	497	1974	8	29	13	18	26.000	17.825	-65.485	33.0N	..	.	GS	4.6	....	...	....	...	....	...	....	2.0F	....	....	
	498	1974	10	8	9	50	58.100	17.300	-62.000	47.0	..	.	GS	6.6	....	7.5H	....	...	....	7.1	PAS	8.0D	....	....	
	499	1974	10	8	18	6	23.700	17.378	-62.006	47.0	..	.	GS	4.8	....	...	....	...	....	...	....	....	....	....	
	500	1974	10	9	14	46	58.200	19.327	-65.184	33.0N	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	501	1974	10	17	8	52	54.600	17.313	-62.087	58.0	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	502	1974	10	18	00	26	42.600	17.601	-62.208	45.0D	..	.	GS	5.2	....	4.4H	....	...	....	...	....	....	....	....	
	503	1974	10	26	5	30	38.000	18.424	-66.320	93.0	..	.	GS	4.7	....	...	....	...	....	...	....	3.0F	....	....	
	504	1974	12	30	20	33	23.100	17.533	-62.027	33.0N	..	.	GS	4.6	....	4.3H	....	...	....	...	....	....	....	....	
	505	1975	3	15	16	39	26.900	18.991	-69.355	64.0	..	.	GS	4.6	....	...	....	...	....	...	....	....	....	....	
	506	1975	3	18	4	19	39.700	19.207	-69.855	39.0	..	.	GS	4.7	....	4.8H	....	...	....	...	....	....F	....	....	
	507	1975	4	10	11	16	5.300	18.466	-70.405	33.0N	..	.	GS	4.5	....	...	....	...	....	...	....	....	....	....	
	508	1975	5	21	23	58	35.500*	19.810	-70.472	33.0N	..	.	GS	4.5	....	3.3Z	....	...	....	...	....	....	....	....	
	509	1975	6	17	5	1	13.500	18.501	-66.341	111.0D	..	.	GS	5.0	....	...	....	...	....	...	....	5.0F	....	....	
	510	1975	8	3	10	35	1.500	19.668	-63.174	35.0D	..	.	GS	5.2	....	4.7Z	....	...	....	...	....	....	....	....	
	511	1975	8	13	5	7	17.600	19.633	-70.526	33.0N	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	512	1975	9	14	3	42	9.000*	18.604	-69.062	95.0	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	513	1975	9	22	5	42	59.300*	20.340	-70.669	34.0	..	.	GS	4.3	....	3.2Z	....	...	....	...	....	....	....	....	
	514	1975	10	31	22	58	47.400	18.983	-69.701	137.0	..	.	GS	3.8	....	...	....	...	....	...	....	....	....	....	
	515	1976	3	29	6	15	41.600	18.348	-65.115	110.0	..	.	GS	4.7	....	...	....	...	....	...	....	3.0F	....	....	
	516	1976	5	7	5	36	57.100	17.367	-62.015	33.0	..	.	GS	4.8	....	...	....	...	....	...	....	4.0F	....	....	
	517	1976	6	13	19	6	27.400	19.044	-67.916	51.0	..	.	GS	5.4	....	...	....	...	....	...	....	....F	....	....	
	518	1976	6	14	4	37	6.400	19.220	-67.876	17.0	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....	
	519	1976	6	15	00	33	49.300	18.863	-69.068	111.0	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	520	1976	6	16	16	35	26.500	18.979	-67.907	55.0	..	.	GS	5.1	....	4.0Z	....	...	....	...	....	....	....	....	
	521	1976	7	2	12	38	12.900	19.810	-70.940	57.0	..	.	GS	5.0	....	...	....	...	....	...	....	....F	....	....	
	522	1976	7	15	00	7	56.600	19.220	-64.130	33.0	..	.	GS	5.0	....	...	....	...	....	...	....	....	....	....	
	523	1976	10	15	19	50	42.000	18.920	-64.470	45.0	..	.	GS	5.0	....	...	....	...	....	5.4	....	....F	....	....	
	524	1976	12	31	16	32	50.300	18.270	-68.860	85.0	..	.	GS	5.1	....	...	....	...	....	...	....	....	....	....	
	525	1977	2	5	15	42	44.300	19.620	-70.180	33.0	..	.	GS	5.0	....	4.8	....	...	....	...	....	....	....	....	
	526	1977	4	5	2	27	0.200	18.850	-67.880	33.0	..	.	GS	4.8	....	...	....	...	....	...	....	....	....	....	
	527	1977	5	2	16	00	54.900	19.070	-67.390	50.0	..	.	GS	5.2	....	...	....	...	....	...	....	....F	....	....	
	528	1977	5	9	2	24	59.000	18.730	-62.900	68.0	..	.	GS	5.0	....	...	....	...	....	...	....	....	....	....	
	529	1977	5	31	10	47	29.000	19.370	-69.500	53.0	..	.	GS	4.9	....	3.4	....	...	....	...	....	....	....	....	
	530	1977	6	4	16	54	29.600	18.870	-64.150	49.0	..	.	GS	4.7	....	...	....	...	....	...	....	....	....	....	
	531	1977	6	6	6	38	46.100	19.390	-69.480	49.0	..	.	GS	4.9	....	4.2	....	...	....	...	....	....	....	....	
	532	1977	6	26	10	15	39.000	19.340	-69.310	35.0	..	.	GS	4.7	....	4.2	....	...	....	...	....	....	....	....	
	533	1977	6	26	13	21	13.200	19.460	-69.210	33.0	..	.	GS	4.8	....	...	....	...	....	...	....	....	....	....	
	534	1977	9	3	15	33	43.400	18.350	-71.150	50.0	..	.	GS	4.5	....	...	....	...	....	...	....	....	....	....	
	535	1977	9	8	8	3	54.100	18.440	-68.890	128.0	..	.	GS	4.9	....	...	....	...	....	...	....	....	....	....	
	536	1977	10	17	6	30	52.100	18.360	-70.260	58.0	..	.	GS	4.7	....	4.0	....	...	....	...	....	....	....	....	
	537	1977	10	18	21	10	32.400	19.180	-64.660	53.0	..	.	GS	4.8	....	...	....	...	....	...	....	....	....	....	
	538	1977	12	3	12	35	38.200	19.130	-69.600	81.0	..	.	GS	5.0	....	...	....	...	....	...	....	....	....	....	

B. EARTHQUAKE HISTORY OF WESTERN PUERTO RICO

<u>North and Central Puerto Rico</u>

1717 Date and Time Unknown
In 1717, a strong and damaging earthquake occurred. The San Felipe Church at Arecibo was completely ruined, and the 100-year-old parish house at San German was destroyed (6).

1828 July 21
An earthquake was felt throughout the island (25).

1865 August 30 Night 1 60 MT
Cracks formed in churches at Manati and Ponce, VI. No report from other places. Origin probably in center part of the island (1, 31). A prolonged earthquake in Puerto Rico (5, 13, 14). A large earthquake was felt (8). Apparently widespread and probably located on the island and deep--50 km to 100 km (JBC).

1875 December 8 Night 60 MT
Arecibo, VII-VIII. Church badly damaged. Little damage elsewhere (31, 1, 8). A strong earthquake was felt in Ponce. Tremors were prolonged, which caused some chimneys to fall at sugar mills (5). The island experienced another strong earthquake (6). Must have been on the island and deep--50 km to 100 km (JBC).

1890 August 15 ±0145 60 MT
A strong and prolonged earthquake was experienced (8). A strong earthquake was felt throughout the island. Reports filed by various towns in Puerto Rico are as follows:

Caguas	1:30 a.m.	35 sec.	Slight damage.
Ponce	2:00 a.m.	8-10 sec.	Jail damage.
Adjuntas	2:00 a.m.	25 sec.	No damage, but felt.
Arecibo	1:55 a.m.	---	Rang church bells.
Barros	2:00 a.m.	---	No damage, but felt.
Dorado	1:30 a.m.	---	No damage, but felt.
Isabela	1:48 a.m.	65 sec.	No damage, but strong noise.
Las Marias	1:45 a.m.	---	No damage, but strong noise.

Toa Alta	2:00 a.m.	---	No damage, but strong noise.
Yauco	2:00 a.m.	15 sec.	No damage, but strong noise. Scared people (29).

1895 March 19
An earthquake occurred in Arecibo (8).

1900 October 29, 30 0420 60 MT (29th)
San Juan and La Isolina, III. Origin probably in central Puerto Rico (1). October 29 only: felt at Bayamon, La Isolina, Manati, and San Juan. The vibrations apparently moved from south to north and lasted 30 seconds. Then, after a few seconds, another vibration was felt. Doors rattled and beds shook, but there was no damage (28).

1900 December 6
La Isolina and Manati. Time given as 3:45 a.m. (1). Slight earthquake felt over northern portion of the island. The vibrations apparently came from the east and moved toward the west. No damage reported. Time reported 2:58 a.m. (28).

1901 August 3, 5, 13, 16, 20
August 3 at 0420: Utuado, San Salvador, and Ponce, III-IV. Origin probably in center of island. August 5 at ?: Utuado. August 13 at 0430: Yauco, strong (V?); duration 3 to 4 seconds. August 16 at ?: Utuado and San Salvador, III-IV. August 20 at 0400: Cayey. Strong (V?) (1). August 3: light earthquake felt at La Isolina, Ponce, San Salvador, and Utuado. August 16: light earthquake felt at Utuado and San Salvador (28). August 20: Cayey. Strong (V?) (31).

1901 December 9 0715 60 MT
Reported fairly generally over Puerto Rico except the southeast and southwest corners, III-IV. Two shocks felt at Arecibo. Origin probably north of the island (1). A light earthquake was felt generally throughout the Island (28). Felt generally over island except southeast and southwest corners. Submarine origin to north (31).

1902 May 19, 22, 30 1313 (19th) and 1100 (22nd) 60 MT
May 19: La Isolina, Utuado, San Salvador, Adjuntas, and Las Marias (?), III-IV. Origin in central part of island. May 22: Cayey, Canovanas and Vieques,

III-IV (1). May 19, 22, 30: light earthquakes were felt at San Salvador, Cayey, Las Marias, Adjuntas, Canovanas, La Isolina, and Vieques. Volcanic smoke was observed throughout the island after May 10 and highly colored sunsets after the 11th, especially on the 22nd and 23rd (28). May 22: Cayey, Canovanas, and Vieques, III-IV (31).

1902 August 10 1500 60 MT
Arecibo, III (1). A slight earthquake was felt at Arecibo (28).

1902 December 1 1930 60 MT
Arecibo, III (1). A light earthquake was felt at Arecibo (28).

1906 September 27 10:41:25 60 MT
The shock was felt from Santo Domingo to St. Thomas, a distance of 500 km, and probably still further east. It was strong all over Puerto Rico, not less than V in any part of the island. At San Juan, objects were overturned and people were frightened. Duration, 50 seconds rising gradually to a maximum then diminishing. Reports were received from many towns but without details. The seismograph at Vieques made a good record. It indicated a distance of about 140 km to origin in a northwest-southeast line. Origin believed to be about 50 km north of Puerto Rico about opposite the middle or a bit further west--about 19°N and 66.5°W. No sea wave. The reported damages were widespread; about 19 Puerto Rico communities reported intensities varying from V to VII. A more complete, detailed account is in the Reid and Taber publication (1). Puerto Rico, V. At about 1015 a severe and prolonged shock (4). A heavy, double-shock earthquake was felt throughout the island. The quake became noticeable at 10:47:30 a.m., increased rapidly in intensity with short, sharp vibrations. There was an apparent east-to-west direction reaching a maximum at 10:47:35 a.m. after which the energy seemed to decrease somewhat for about 10 seconds and then increased reaching the greatest energy at 10:47:55 a.m. The vibrations then rapidly decreased in intensity but continued perceptibly until about 10:48:20 a.m. The walls of some buildings were cracked, some clocks stopped, and great confusion among people resulted, but no material damage was done (28). At least V in all parts of the island. Caguas, VI-VII. Rio Riedras, VI-VII. Cayey, V. San Juan, VII. Bayamon, VI-VII. Origin 50 miles north of Puerto Rico (31).

1906 October 20 1610 60 MT
Felt generally throughout Puerto Rico, IV-VI. Reported from Anasco, Isabela, Arecibo, Lares, La Carmelita, Juana Diaz, San Juan, Las Cruses, and Central Ingenio. Origin probably in west central part of the island (1, 31). Felt by many stations. Seismograph at San Juan recorded only vertical motion (28). Widespread felt reports and vertical motion indicate that the shock was probably deeper than normal--50 km (JBC).

1907 September 4 1045 60 MT
Central part of island, III-IV. Reported from San Juan, Arecibo, Utuado, Maricao, slight record at Vieques. Origin probably near center of the island (1, 28).

1909 May 10 1045 60 MT
Arecibo (1). Arecibo (Bacupay) slight (28).

1919 August 9 0750 60 MT
Apparently local (1). Felt at Arecibo (28).

1919 August 18
Felt at Arecibo (28).

1925 June 12 1900 60 MT
Light shock felt at Arecibo (28).

1925 August 19 0006 60 MT
Intensity (RF) V. Shock lasted 15 to 20 seconds. Aftershock at 0110 and 0500; less severe than first shock (1). Felt strongly at San Juan preceded by loud rumble. No casualties. Felt over all the island (22).

1928 August 22 0450 60 MT
Shock felt generally throughout the island. Two shocks felt at Mayaguez; also felt at Orocovis, Aguirre, and San Juan (1). Felt at Bayamon; duration 34 seconds (3-4 seconds?) (28). Felt throughout the island. Reported from Mayaguez and San Juan (31). Because of widespread felt report, shock was probably deeper than normal, 50 km to 100 km and centered near middle of the island (JBC).

1928 November 18 2235 60 MT
Many people alarmed at Orocovis. East-west swaying at San Juan. Also felt at Mayaguez (1). Felt at Barros (bumping nature, rapid onset, no damage reported), Mayaguez (swaying motion, gradual onset,

cracking sound, no damage), and San Juan (swaying nature, eastward motion, gradual onset, felt by many) (28). San Juan and Mayaguez (31).

1950 October 6 0416 MT
19.57°N and 65.43°W; M = 4.4 (32). Weak. 20°N and 66°W. Off northern coast of Puerto Rico (35).

1951 September 15 04:11:23 60 MT
18.33°N and 65.70°W; h = 96 km (32). Strongly felt at San Juan and throughout the island. The epicenter occurred at a depth of about 100 km and probably 85 miles from San Juan (33).

1952 August 27 1301 60 MT
Felt in San Juan and Caguas. The earthquake was of low intensity (22). 19.09°N and 66.58°W; M = 4.2; h = 52 km (32). Epicenter 18.5°N and 66.5°W. Felt at Caguas and at San Juan (33).

1953 February 21 18:17:46 60 MT
An earthquake was felt in Puerto Rico on February 21. It was of low intensity and probably located in western part of the island about 65 km to 80 km from the Coast and Geodetic Survey Observatory at Guaynabo. Felt reports were received from Humacao and Sabana Grande (22). 18.20°N and 66.22°W; h = 120 km (32). Felt in various parts of Puerto Rico (33).

1954 February 9 04:56:38 60 MT
19.12°N and 65.15°W; M = 4.2; h = 68 km (32). 19°N and 64°W. Depth 60 km. Felt (35).

1956 February 13 11:33:16 60 MT
Headlines: "An Earthquake Shakes Several Towns." Story: "A moderate to high intensity earthquake located approximately 60 km northwest of the Guaynabo Observatory" (22). 18.93°N and 66.30°W; M = 4.1 (32). Epicenter 19°N and 66.5°W. Felt over entire island of Puerto Rico. Intensity V at Aguadilla, Caguas, and Mayaguez (33).

1961 August 2 23:08:05 60 MT
Coast and Geodetic Survey Observatory at Guaynabo reported a moderately intense earthquake at 11:08:24 p.m. The quake was centered about 20 to 24 miles off the coast of Aguadilla causing considerable alarm and some minor property damage. The motion lasted from 8 to 10 seconds (22). 18.49°N and 66.42°W (32). Epicenter 18.4°N and 66.3°W. Depth about 132 km.

Felt strongly throughout Puerto Rico. Also felt by several on St. Thomas, Virgin Islands. Buildings cracked and loose objects rattled. Intensity V at the following Puerto Rico locations: Aguadilla, Caguas, Fortuna, Guaynabo, Humacao, Mayaguez, Utuado. Intensity IV at Cayey and Guayana (33).

1964 July 14 05:55:24 60 MT
A low intensity earthquake was felt in Puerto Rico at 5:55:38 a.m. on July 14. Its duration was 4 or 5 seconds. Aftershocks occurred at 6:17 a.m., 6:19 a.m., and 7:16 a.m. The 7:16 a.m. aftershock was probably felt throughout the island (22). 19.00°N and 66.50°W; M = 4.3 (29). Felt slightly in Puerto Rico, epicenter 19.0°N and 66.5°W. Depth 46 km. Mag 4.25-4.5 (PAL) (33).

Other Events in Central Puerto Rico

1903 February 18 2030 60 MT
Utuado, III-IV (1). Light earthquake felt at Utuado (28).

1904 July 2 ±2145
La Isolina, Utuado, and Lares, III-IV. Origin in west central part of the island (1). A light earthquake was felt at several stations between 9:30 and 10:00 p.m. (28).

1912 January 11, 12
January 11 at 1845 at Jayuya. January 22 at 1330 at San Salvador (1, 28).

1914 January 31 2300 60 MT
San Sebastian (1). Felt at San Sebastian (28).

1936 February 2 1506 60 MT
Utuado, IV. Recorded at San Juan (seismograph?) (1).

Southwest Puerto Rico

1740 August 30
Destroyed the main church at Ponce (5). Totally destroyed the Guadalupe Church at Ponce (22).

1787 May 10
A strong shock cracked walls of Guadalupe Church at Ponce. Church was later repaired At San Juan, the cathedral suffered much damage as did the Fort and other buildings. People deserted the city in great fear (5).

1844 May 5
A strong shock felt in Ponce accompanied by a profound subterranean noise (5). A great earthquake in Puerto Rico (8). A terrible earthquake in all the island (14).

1899 July 10 2000 60 MT
Lajas; strong V. Yauco also felt two shocks. Another shock at 0200 on July 11 (1). Felt at Yauco, La Isolina, Lajas, Utuado, and Ponce (28).

1902 January 5 1805 60 MT
Las Marias and Juana Diaz, III-IV (1). Reported felt at Las Marias and Juana Diaz (28).

1903 December 29 0321 60 MT
Ponce, V (1). Light earthquake felt at Ponce (28).

1904 March 14 0630 60 MT
Ponce, V; Lares, III (1). Light earthquake felt at Ponce and Lares (28).

1904 December 13 2105 60 MT
South central part of the island, III-IV. Reported from Utuado, San Salvador, La Carmelita, and Ponce (1, 28).

1908 August 4 0620 60 MT
Strong at Ponce, VI, where little damage was done. Light at Las Cruces, Alta de la Bandera, Arecibo, San German, Yauco, and San Salvador. A second shock was reported from Alta de la Bandera and Las Cruces at 10:00 p.m. Origin probably in southern part of the island (1, 28).

1908 August 13 0407 60 MT
Strong shock felt at Ponce where post office suffered some damage, VI. Movement apparently vertical. Light at La Carmelita. Origin probably near Ponce (1, 28).

1908 October 31 0608 60 MT
Ponce, V (1). Sharp at Ponce (28). Probably near same location as shock on December 13, 1904, and August 13, 1908 (JBC).

1909 March 7 1100 60 MT
Ponce, III (1). Light at Ponce (28).

1911 May 29 1300 60 MT
Ponce (1). Light at Ponce (28).

1911 October 23
Ponce (1, 28).

1913 January 30
Ponce (1, 28).

1953 July 6
Felt at Ponce, Puerto Rico (33).

1955 January 13
Weak. Felt at Ponce. No damage reported (35).

1959 November 21 0721 60 MT
Coast and Geodetic Survey Observatory at Guaynabo reported earthquake at 0721 on November 21 and at 0922 on November 22. Both were located about 50 miles in a southeasterly direction. From Sabana Grande: An earthquake of low intensity occurred at 7:20 a.m. The noisy roar that preceded it caused people to run into the streets (22). Felt by and alarmed many at Sabana Grande. Also felt at San German and Lajas (33). Felt at Sabana Grande. Epicenter in that region (35).

1966 May 2 0300 60 MT
Felt at central San Francisco and at Guayanilla. Three shocks felt on this date. Trembling motion (33).

1967 February 1 1923 60 MT
Central San Francisco. Intensity V. Felt by all; many frightened. Windows, dishes, and walls rattled. Moderate earth noises. Motion rapid (33). Felt at Guayanilla (36).

1967 February 3 0121 60 MT
Felt by many at central San Francisco, V. Windows rattled. Three shocks felt in 3 hours; one foreshock at 0025 (33).

1967 February 13 1926 60 MT
Felt at central San Francisco, V. Houses rattled and shook. Loud earth noises. Motion rapid, north direction. Second shock a few seconds after the first one, and some people felt another shock in the middle of the night (33).

1967 February 21 1251 60 MT
Felt in Guayanilla area (36).

1967 November 25
Felt in Guayanilla area (36).

1967 December 20 2232 60 MT
Felt in Guayanilla area and southeast coast (36).

1969 September 28 0202 60 MT
Intensity IV at Boca, central San Francisco, and Guayanilla (33).

Mayaguez Area

1524-28 Date and Time Unknown
The author states that it is probable that the house of Ponce de Leon at Anasco was destroyed by a violent earthquake between 1524 and 1528. The quake also destroyed other strong buildings. The shock was felt strongest in the north over all the region from Mayaguez to Anasco (12).

1831 September 7 0500 60 MT
Aguadilla. Strong shock (V?) lasting 3 seconds (1).

1848 Date and Time Unknown
Mayaguez. Several light shocks felt during the month (1). Listed as Mayaguez, Puerto Rico (3).

1850 April 8 0900 60 MT
Mayaguez, where church bells rang. The shock reported from Martinique on this date must have had a different origin (1).

1860 October 23
Mayaguez. Rather strong shock with some damage, VI-VII (1).

1864 May 30
Mayaguez. Light shock, III (1).

1866 February 7 0800 60 MT
Mayaguez, IV (shocks at 0800, 1300, 2015, and 2300). The report for January 7 and February 7 may refer to the same shock (1).

1901 June 1 0935 60 MT
San German, III (1).

1901 November 27
Felt at Las Marias (28).

1901 December 27
Las Marias, III (1). Felt at Las Marias. No damage (28).

1902 August 29
San Salvador and San German, III (1). Felt at San Salvador and San German. Slight (28).

1902 September 2
San German, III-IV (1). Light earthquake felt at San German (28).

1903	February 15 Las Marias (1).. Light earthquake felt at Las Marias (28).
1904	June 9 Las Marias, III-IV (1). Light earthquake felt at Las Marias (28).
1906	January 18 0615 60 MT San German, III-IV (1). San German. Light; duration about 8 seconds (28).
1912	September 24 San German and San Salvador (1). Weather Bureau reported this quake on December 24, 1912, showing felt reports from San German and San Salvador (28).
1913	August 5 2030 60 MT Cabo Rojo (1). Felt at Cabo Rojo (28).
1916	November 18 Maricao (1, 28).
1917	October (or November) Dates unknown. Mayaguez, VI; cracked walls in some houses. Vertical movement (1).
1920	March 7, April 12, June 1, June 29, August 7, September 9 Las Marias (28).
1921	March 19 1815 60 MT Felt at Cabo Rojo (28).
1922	January 3 2120 60 MT Mayaguez reported an earthquake January 3 at 9:30 p.m. It was felt strongly, and the public was alarmed. Another shock was felt at approximately 10:00 p.m. There was no damage, but both shocks caused considerable panic (22, 28).
1922	May 4 0750 60 MT Reported felt at Mayaguez; about 5 seconds duration; direction east-west. Also reported from Canovanas at 0737 and from Jayuya (28).
1922	November 3 0145 60 MT Mayaguez reported the shock as having a trembling nature; intensity II; duration 5 seconds; direction east-west (28).

1922 December 9 0035 60 MT
Mayaguez reported seismic tremor of rocking nature; duration 2 seconds; intensity II (28).

1922 December 30 0205 60 MT
Felt in Mayaguez; duration about 3 seconds; direction east-west. Aftershock of rocking nature also reported by Mayaguez with intensity of III; duration 7 seconds; direction east-west (28).

1923 February 26 0630 60 MT
Felt at Mayaguez. Three shocks of rocking nature. Onset gradual with duration of about 6 seconds; direction east-west; intensity III (28).

1923 June 10 2130 60 MT
Shock of rocking nature reported by San Juan and Rio Piedras; onset abrupt. Mayaguez reported four shocks beginning at 2109 of rocking nature, each shock of about 1 second duration; direction east-west; intensity III; onset gradual. Also, Mayaguez reported three shocks of rocking nature at 1700 on June 14; onset gradual; direction east-west; duration 2 seconds each; intensity III (28).

1923 October 25 0824 60 MT
Felt at Mayaguez. Onset gradual; trembling nature; duration 5 seconds; intensity V; direction east-west (28).

1925 January 25 1305 60 MT
Three moderate shocks were felt at Mayaguez. Direction east-west; duration about 3 seconds; rocking nature with an intensity of III (28).

1928 April 13 1920 60 MT
Two shocks at Mayaguez. Rapid onset; trembling nature; felt by many (28).

1931 September 19 2350 60 MT
Moderate shock at Mayaguez felt as a gently rhythmic motion and in a pronounced north-south direction. Felt at Santurce with less intensity. Recorded at San Juan. Four shocks recorded on September 19 and 20 (1). Felt in Mayaguez and San Juan (31).

1931 September 25 1435 60 MT
Moderate shock at Mayaguez. Bumping and slight swaying (1).

1936 December 11 2219 60 MT
Mayaguez, IV. Recorded at San Juan (seismograph?) (1).

1937 September 9 2020 60 MT
San German. Aftershock at 2400, same date (1).

1937 September 11 0638 60 MT
Slight shock at San German. Probably an aftershock of September 9 shock (1).

1937 October 4 0477 60 MT
Tremor at Ponce and San German. Awakened observers (1).

1939 January 1 0400 60 MT
Sabana Grande. Slight, but felt by many (33).

1955 October 10 0030-0100 60 MT
A high intensity earthquake was felt in Mayaguez that caused great concern. It lasted about 30 seconds. It started with a high tremor reducing in intensity in its final stages. El Mundo newspaper notes that the Coast and Geodetic Survey Observatory at Guaynabo said it recorded no earthquake on this date (22).

1958 July 16
Weak. Felt at Mayaguez (35).

Mona Passage and Northwest Puerto Rico

1846 November 28 1700 60 MT
Felt throughout Puerto Rico with highest intensity VII, northwestern part. Church at Isabela again damaged. VI at Cabo Rojo and Arecibo; V at San Juan. Epicenter probably in Mona Passage (1). Listed as Puerto Rico only (3). Another earthquake occurred in Puerto Rico (8). An earthquake occurred in Puerto Rico on November 28, 1846 (23). Probably in Mona Passage. VII (RF scale) in northwestern part. Felt all over Puerto Rico (31).

1847 December 18
An earthquake was registered on the west coast of Puerto Rico (23).

1866 April 8 0450 60 MT
Western Puerto Rico, V. Duration 20 seconds. Reported from Ponce, Mayaguez, and Aguadilla. There was an aftershock on April 10 at 0300 (1).

1883 February 19 1900 60 MT
Ship Siddartha reported a sharp earthquake in the Mona Passage. Ship trembled as if dragging over a hard bottom but found no sounding at 30 fathoms. The ship's position was 20°04'N and 67°45'W (1).

1900 February 13 2101 60 MT and 2203 60 MT
Felt over northwestern part of Puerto Rico, V. Many cities reporting. Aftershock at 2203, same date (1). A light earthquake was felt over the entire northern half of the island. Apparently, it was felt at the extreme western end of Puerto Rico at Aguadilla at about 9:00 p.m. Traveling in an easterly direction, the seismic vibrations were noted all the way to Canovanas where it was timed at 9:15 p.m. No damage was reported. At 10:00 p.m., another light shock was felt at Aguadilla, Isabela, La Isolina, and other localities nearby. Its direction was the same as the first but less intense (28).

1907 July 5 0420 60 MT
Western third of Puerto Rico, IV-V. Reported from Utuado, La Carmelita, Coloso, Anasco, Aguadilla. Origin in western part of the island (1, 28).

1910 September 9 2156 60 MT
Felt generally in Puerto Rico, V-VI, in western part where quake originated (1, 31). Stations in all parts of the island reported light shocks on September 9, the shocks having been strongest in the

extreme western portion. Shocks felt on other dates were: Cidra, 11th; La Carmelita, 10th and 11th; and San Salvador, 6th and 8th (28).

1915 February 17 0935 60 MT
Arecibo, IV; Mayaguez, IV-V; Lares, II-III; Isabela; and Bacupey. The lower intensity in Lares is due to more stable foundation. Origin of earthquakes of February 1, 3, and 17 in western part of island (1). Felt at Arecibo, Isabela, and Bacupey (28).

1915 October 11 15:33:12 60 MT
Felt over a large part of the island; strongest in western part, V. Felt as far east as Canovanas, III, and as far west as Puerto Plata, Dominican Republic. Felt reports from many Puerto Rican cities. Origin apparently a little north of Mona Passage (1, 28, 31). 19°N and 67.0°W; M = 6.75 (29).

1916 April 24 00:36:46 60 MT
Origin in eastern part of Dominican Republic where the intensity was VIII-IX. Felt all over Puerto Rico (about VI on west coast) and as far as Vieques, II-III (1). 18.5°N and 68.0°W; M = 7.2; h = 80 (Gute) (29).

1917 July 13 0014 60 MT
Origin a little northwest of Mona Passage. Felt at Mayaguez, IV, and at Puerto Plata, Dominican Republic, III (1).

1917 July 26 2101 60 MT
A series of shocks generally noticed over Puerto Rico between July 26-28. The origin was off the northeast coast of Santo Domingo about 19.5°N and 68.5°W where it must have been fairly strong. The strongest shock occurred at the beginning. Felt all over Puerto Rico. Mayaguez, VI. San Juan, V (1, 28, 31).

1918 October 11 10:14:30 60 MT
18.5°N and 67.5°W; M = 7.5 (Gute) (29). This is a well documented earthquake. Tsunami accompanied the earthquake (1, 27, 28, 29, 31).

1918 October 24 2343 60 MT
Aftershock of October 11, VII in northwest Puerto Rico (1, 27, 28). A strong earthquake which damaged buildings in Mayaguez (4).

1918 November 12 1745 60 MT
Aftershock of October 11 earthquake VI-VII in northwest Puerto Rico (1). Felt generally throughout Puerto Rico causing much additional damage to already damaged buildings. Strong foreshock 0800 November 12 (28).

1918 November 25 0150 60 MT
Seismic activity continued with greatly diminished intensity during the month. The latest earthquake reported felt generally in Puerto Rico was on this date (28).

1920 February 10 1807 60 MT
Felt in Puerto Rico and at Jigureo Lighthouse (1). El Mundo newspaper special report: "In spite of the alarm and panic experienced by the people of some cities, no casualties or damage was reported" (22). 18°N and 67.5°W; M = 6.5 (30).

1922 December 18 0836 60 MT
Felt in Puerto Rico (1). Ponce reported that shock was strong at 0845. Many families ran into the streets greatly alarmed. No damage reported, but quake was felt by many people (22). San Juan reported tremor of rocking nature; duration 2 seconds; intensity III; direction east-west. Mayaguez reported tremor of rocking nature; duration east-west. San German reported an intensity of III. Shock was also reported felt at Humacao, Jayuya, and Cidra (28). 19°N and 67°W; M = 6.25 (30).

1923 March 15 0203 60 MT
Shock felt in Puerto Rico, especially near Mayaguez (1). Bayamon reported a strong shock followed by a series of shocks of 30 seconds duration. Felt at Arecibo, Canovanas, Cidra, Dorado, Humacao, Jayuya, Mayaguez, Maricao, and San German. Shock was probably centered a few miles northwest of Puerto Rico (28). 20°N and 68°W; M = 5.6 (30). It is likely that the epicentral location determined by (30) is in error since the shock was relatively light but was felt strongly throughout northern and western Puerto Rico (JBC).

1926 April 22 0245 60 MT
Report of a local tremor felt in western Puerto Rico (1). Felt at Maricao (28).

1926 December 9 2202 60 MT
Intensity (RF) IV at Mayaguez; at San Juan and other locations (RF) III (1). Felt at Canovanas, Arecibo, Comerio Falls (trembling nature, duration 30 seconds, onset gradual, no damage), Mayaguez (trembling nature, 2 seconds duration, direction east-west, intensity V, accompanied by faint sound), Manati (duration about 4 seconds), and San Juan (28). Mayaguez, IV; Bayamon; Comerio Falls; San Juan; and Manati, III (31).

1927 October 19 0600 60 MT
Intensity (RF) IV at Mayaguez. Intensity II at other locations in Puerto Rico. Aftershock at 0615, same date (1, 28, 31).

1929 October 16 0525 60 MT
San German. Aftershock of 0620, same date. People generally alarmed at Mayaguez; two shocks with east-west oscillation caused alarm. Rocking motion felt at Canovanas (1, 22, 28, 31). Epicenter probably in Mona Passage or on the western side of the island (JBC).

1943 July 28 23:02:16 60 MT
19.25°N and 67.5°W; M = 7.75 (29). San Juan. Felt by many. Off northwest coast of Puerto Rico (31). Felt at San Juan (33).

1943 July 29 21:02:30 60 MT
19.25°N and 67.75°W; M = 6.5 (29). San Juan. Stopped clocks. Felt by thousands throughout Puerto Rico (31).

1944 August 9 00:15:30 60 MT
18.5°N and 67.0°W; M = 5.6; h = 60. Felt (29).

1949 December 21 0831 60 MT
18.5°N and 67.0°W; h = 100 km. Western Puerto Rico (34). Felt at San Juan, Ponce, Mayaguez, Humacao, Caguas, and other cities in Puerto Rico (35).

1950 January 1 2042 60 MT
19.03°N and 67.72°W; M = 4.70 (32). Felt at Mayaguez and other towns (33).

1952 November 21 02:10:34 60 MT
19.33°N and 67.90°W; M = 4.3 (32). 20°N and 63°W. Northeast of Puerto Rico (35). The Sykes location

places the earthquake about 70 miles northwest of Aguadilla, near Mona Passage.

1953 August 21 09:31:38 60 MT
19.04°N and 67.65°W; M = 4.4 (32). Weak. Distance 250 km, near west coast of Puerto Rico. 18°N and 67°W (35).

1955 February 18 04:06:43 60 MT
19.02°N and 68.0°!W; h = 74 km (32). Weak. Felt. 19.5°N and 68°W; depth 60 km (35).

1955 December 21 07:58:33 60 MT
18.09°N and 67.88°W; h = 22 (32). Felt at Ramey Air Force Base. Epicenter at Mona Passage (33).

1959 January 7
Felt around southwest corner of the island. No damage reported. Felt at Cabo Rojo, San German, Mayaguez, and San Juan (33).

1959 January 26 20:20:25 60 MT
Reported by the Coast and Geodetic Survey Observatory at Guaynabo as being in Mona Channel with duration of about 35 seconds. Felt in Morovis for about 10 seconds (22). 18.03°N and 68.63°W; h = 94 km (32). Felt at Morovis, Mayaguez, and San Juan. Epicenter 18°N and 68.5°W. Depth 100 km. Intensity VI at Moca, Puerto Rico (33).

1959 July 21 05:17:56 60 MT
18.87°N and 68.04°W; M = 5.3. 19.0°N and 68.50°W. Felt throughout Puerto Rico. Intensity IV (32) from following locations: Aibonito (felt by several), Coloso (felt by many), Corozal (felt by many), Isabela, Lares, Maricao, Mayaguez, Quebradillas, Rincon, San Sebastian, and Utuado (felt by many) (33).

1961 August 19 10:52:29 60 MT
An earthquake was felt on August 19 at about 11:00 a.m. according to reports from Ponce, Morovis, and Rio Piedras (22). 18.08°N and 68.81°W; M = 5.5; h = 146 km. Mona Passage (32, 33).

1964 December 22 04:01:13 60 MT
18.40°N and 68.80°W; M = 5.6; h = 115 (29). Felt widely on Puerto Rico (33).

1965 May 17 03:26:27 60 MT
18.2°N and 67.8°W; M = 4.1; h = 60. Felt weak (29, 36).

1966 November 3 07:37:22 60 MT
19.1°N and 67.9°W; M = 5.2; h = 37 (29). Mona Passage (36). Foreshock of next earthquake shown. Probably felt in west Puerto Rico (JBC).

1966 November 3 12:24:33 60 MT
19.2°N and 68.0°W; M = 5.6; h = 33 (29). Epicenter 19.2°N and 67.9°W. Mona Passage at a depth of 22 km, magnitude 6-6.25. Intensity V. At Ponce several people ran into the streets, and some records fell to the floor in radio studios. Buildings shook for 6 or 7 seconds in San Juan. The shock was also felt at Caguas, Cayey, and at the Playa de Ponce area (33).

1966 November 4 06:52:57 60 MT
19.2°N and 67.8°W; M = 4.7; h = 33 (29). Aftershock felt on west coast of Puerto Rico (36).

1968 April 12 21:15:32 60 MT
19.0°N and 66.9°W; M = 5.1. Intensity IV at Guayanilla. Also felt at San Juan (33).

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Appendix C Catalog of western Puerto Rico Microseismicity

[UTC, Coordinated Universal Time; negative latitudes and longitudes are south and west, respectively; M, magnitude; a, b, and c, principal axes of confidence ellipsoid; Tr, trend of axis in degrees; Pl, plunge of axis in degrees; %, confidence level; Rms, root-mean-square of residuals; No obs, number of observations used in hypocenter computation; Gap, quality index; leaders (.....) designate instances where data values were not computed]

Catalog		Origin time (UTC)						North latitude	East longitude	Focal depth		Error ellipsoid axes										Rms	No	
Name	Index	Yr	Mo	D	H	Min	S	(deg)	(deg)	(km)	M	a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	%	(S)	ob	Q
PR197	1	1976	2	1	6	42	58.400	17.826	-67.045	22.7	1.0D	2.6	90	0	2.9	0	0	3.3	0	90	68	0.18	6	D
	2	1976	2	1	22	58	9.660	18.030	-66.866	4.0	1.5D	2.4	90	0	0.7	0	0	2.5	0	90	68	0.19	7	C
	3	1976	2	2	8	00	18.780	18.175	-67.341	15.6	2.1D	0.8	90	0	1.1	0	0	3.2	0	90	68	0.07	7	C
	4	1976	2	2	15	52	19.410	18.260	-67.644	10.1	2.2D	1.1	90	0	1.0	0	0	1.8	0	90	68	0.09	8	C
	5	1976	2	5	8	7	36.500	18.054	-67.122	14.0	1.3D	0.8	90	0	0.8	0	0	1.0	0	90	68	0.05	6	C
	6	1976	2	7	6	48	5.060	18.179	-67.013	20.7	2.7D	0.6	90	0	0.7	0	0	1.3	0	90	68	0.11	10	B
	7	1976	2	9	22	16	23.680	18.069	-66.898	7.3	1.6D	1.2	90	0	0.4	0	0	0.9	0	90	68	0.17	11	C
	8	1976	2	15	13	11	14.400	18.490	-66.718	16.2	2.3D	1.5	90	0	1.2	0	0	1.2	0	90	68	0.20	9	C
	9	1976	2	15	21	18	14.150	17.826	-66.958	15.1	1.1D	1.4	90	0	0.9	0	0	3.2	0	90	68	0.05	5	C
	10	1976	2	16	3	21	40.760	17.896	-66.842	4.2	1.8D	1.5	90	0	0.5	0	0	0.9	0	90	68	0.10	7	C
	11	1976	2	17	2	57	10.260	18.218	-67.435	21.1	1.2D	1.1	90	0	1.9	0	0	1.2	0	90	68	0.10	7	C
	12	1976	2	19	13	47	48.080	18.121	-66.905	34.2	1.4D	4.3	90	0	1.2	0	0	4.5	0	90	68	0.07	5	D
	13	1976	2	22	13	54	16.310	18.070	-66.919	18.2	1.2D	1.4	90	0	0.6	0	0	3.9	0	90	68	0.08	6	C
	14	1976	2	24	3	48	42.960	17.826	-66.708	3.0	1.4D	1.7	90	0	0.9	0	0	2.0	0	90	68	0.09	6	C
	15	1976	2	24	4	32	44.600	17.805	-66.699	8.3	1.2D	2.4	90	0	0.9	0	0	4.8	0	90	68	0.15	7	D
	16	1976	3	4	13	34	36.460	18.046	-67.073	20.3	1.7D	0.7	90	0	0.4	0	0	1.0	0	90	68	0.06	8	B
	17	1976	3	5	1	12	48.350	17.850	-66.806	0.5	1.8D	0.8	90	0	0.4	0	0	0.9	0	90	68	0.12	11	C
	18	1976	3	6	4	54	34.430	18.148	-67.014	22.2	2.3D	0.5	90	0	1.1	0	0	1.5	0	90	68	0.11	10	B
	19	1976	3	6	13	47	13.690	18.252	-67.175	30.7	1.3D	0.6	90	0	1.4	0	0	1.4	0	90	68	0.10	7	C
	20	1976	3	6	22	51	34.110	18.660	-66.802	68.3	1.9D	2.7	90	0	0.5	0	0	2.3	0	90	68	0.07	10	D
	21	1976	3	7	23	11	39.410	18.707	-67.715	11.9	3.2D	1.9	90	0	0.9	0	0	1.2	0	90	68	0.05	11	C
	22	1976	3	8	2	32	11.860	18.131	-67.530	67.8	3.2D	2.3	90	0	0.8	0	0	2.3	0	90	68	0.13	13	C
	23	1976	3	8	7	5	20.480	18.082	-67.049	15.5	2.0D	0.8	90	0	0.8	0	0	2.4	0	90	68	0.13	10	B
	24	1976	3	8	21	12	30.460	18.941	-67.193	19.7	2.0D	2.4	90	0	2.9	0	0	2.9	0	90	68	0.12	7	D
	25	1976	3	12	9	52	0.490	18.107	-66.898	24.0	0.8D	0.2	90	0	0.1	0	0	0.3	0	90	68	0.02	6	B
	26	1976	3	12	23	29	8.080	18.177	-67.384	7.7	2.5D	1.3	90	0	3.9	0	0	4.9	0	90	68	0.16	11	D
	27	1976	3	13	00	20	25.220	18.009	-67.075	15.0	2.4D	1.3	90	0	1.2	0	0	2.4	0	90	68	0.18	11	C
	28	1976	3	13	00	59	5.770	17.968	-67.085	18.0	1.0D	0.7	90	0	0.5	0	0	0.6	0	90	68	0.07	7	C
	29	1976	3	13	8	14	13.610	17.969	-67.086	18.0	1.0D	1.2	90	0	0.8	0	0	1.0	0	90	68	0.12	8	C
	30	1976	3	13	8	52	5.810	17.970	-67.084	17.4	0.5D	0.8	90	0	0.6	0	0	0.8	0	90	68	0.06	6	C
	31	1976	3	14	22	43	51.740	17.959	-66.782	8.6	1.3D	1.8	90	0	0.8	0	0	0.8	0	90	68	0.16	8	C
	32	1976	3	15	00	54	53.790	17.986	-67.073	16.3	1.1D	1.1	90	0	0.8	0	0	1.1	0	90	68	0.14	9	C
	33	1976	3	16	19	36	4.720	18.487	-67.372	20.8	1.5D	2.7	90	0	2.5	0	0	1.8	0	90	68	0.10	7	D
	34	1976	3	17	6	54	57.970	17.805	-66.774	5.6	1.6D	2.4	90	0	1.8	0	0	1.2	0	90	68	0.15	7	D
	35	1976	3	17	7	53	30.480	18.103	-66.590	24.4	0.6D	2.8	90	0	1.4	0	0	1.6	0	90	68	0.13	6	C
	36	1976	3	17	8	15	4.060	18.232	-67.428	71.7	1.4D	2.1	90	0	0.8	0	0	2.0	0	90	68	0.10	8	C
	37	1976	3	18	19	3	17.440	18.224	-66.989	25.6	1.1D	0.7	90	0	0.5	0	0	1.2	0	90	68	0.07	6	B
	38	1976	3	22	14	9	29.220	18.658	-66.620	16.3	2.0D	1.6	90	0	0.3	0	0	4.7	0	90	68	0.09	10	C
	39	1976	3	25	16	38	12.640	18.573	-66.629	86.6	1.9D	2.1	90	0	0.6	0	0	1.8	0	90	68	0.11	11	C
	40	1976	3	26	21	52	49.260	18.108	-67.238	20.4	2.0D	0.9	90	0	1.7	0	0	1.0	0	90	68	0.08	7	C
	41	1976	3	28	20	32	49.190	17.962	-66.767	15.5	1.0D	1.5	90	0	0.6	0	0	1.1	0	90	68	0.07	7	C
	42	1976	3	29	5	21	59.530	18.880	-67.571	21.3	3.4D	3.9	90	0	1.3	0	0	1.7	0	90	68	0.09	9	D
	43	1976	3	29	5	33	56.900	18.940	-67.552	10.6	1.9D	2.6	90	0	3.7	0	0	2.8	0	90	68	0.09	7	D
	44	1976	3	30	8	22	2.810	17.954	-67.091	17.4	0.8D	1.0	90	0	0.7	0	0	0.8	0	90	68	0.10	8	C
	45	1976	4	1	4	58	29.790	18.246	-67.227	22.9	0.8D	0.6	90	0	1.2	0	0	1.5	0	90	68	0.11	7	C

Appendix C Catalog of Western Puerto Rico Microseismicity--Continued

Catalog Name	Index	Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	M	a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	%	Rms (S)	No ob	Q	*
PR197	46	1976	4	1	22	30	33.160	18.796	-67.041	52.5	1.6D	1.6	90	0	1.3	0	0	2.1	0	90	68	0.15	12	C	
	47	1976	4	3	1	5	34.340	18.825	-67.439	23.0	2.2D	2.7	90	0	3.1	0	0	1.8	0	90	68	0.15	9	D	
	48	1976	4	3	4	40	45.170	18.804	-67.296	26.9	3.1D	1.9	90	0	2.6	0	0	1.5	0	90	68	0.20	12	D	
	49	1976	4	3	4	45	18.450	18.731	-67.220	27.3	2.6D	2.6	90	0	2.2	0	0	1.3	0	90	68	0.13	9	D	
	50	1976	4	3	5	55	29.860	18.649	-66.820	23.5	1.5D	1.8	90	0	1.1	0	0	3.4	0	90	68	0.20	11	C	
	51	1976	4	3	13	18	27.290	17.809	-66.798	3.7	1.5D	2.7	90	0	1.4	0	0	2.0	0	90	68	0.15	6	D	
	52	1976	4	3	13	27	34.920	18.179	-66.867	28.1	1.4D	0.6	90	0	0.4	0	0	0.6	0	90	68	0.09	9	B	
	53	1976	4	4	20	19	13.060	18.009	-67.302	6.2	1.7D	1.0	90	0	0.9	0	0	0.5	0	90	68	0.08	7	C	
	54	1976	4	5	4	40	22.920	18.096	-67.008	11.2	1.4D	0.3	90	0	0.3	0	0	1.5	0	90	68	0.05	8	B	
	55	1976	4	5	16	19	23.330	18.327	-66.854	18.8	1.4D	0.6	90	0	0.4	0	0	2.5	0	90	68	0.05	6	C	
	56	1976	4	6	2	56	10.560	17.866	-66.797	1.7	2.3D	1.6	90	0	0.7	0	0	1.5	0	90	68	0.18	9	C	
	57	1976	4	7	2	12	26.270	18.196	-66.755	6.9	0.6D	0.7	90	0	0.4	0	0	0.8	0	90	68	0.09	7	B	
	58	1976	4	7	16	1	47.720	18.349	-66.851	32.4	1.2D	1.8	90	0	1.0	0	0	3.4	0	90	68	0.11	7	B	
	59	1976	4	7	22	50	2.160	18.247	-67.397	8.5	1.5D	0.7	90	0	2.6	0	0	3.5	0	90	68	0.12	8	D	
	60	1976	4	8	10	56	57.730	18.665	-67.173	27.1	2.6D	4.6	90	0	1.3	0	0	2.0	0	90	68	0.19	9	D	
	61	1976	4	9	21	51	16.830	18.492	-66.821	19.5	2.7D	0.8	90	0	0.2	0	0	0.9	0	90	68	0.06	10	C	
	62	1976	4	11	23	10	22.360	18.702	-66.786	64.8	2.1D	2.4	90	0	0.9	0	0	2.7	0	90	68	0.13	10	D	
	63	1976	4	13	16	11	41.120	18.323	-66.864	6.4	1.6D	1.0	90	0	0.5	0	0	1.2	0	90	68	0.12	9	C	
	64	1976	4	13	21	56	3.170	18.219	-67.048	33.0	0.8D	0.6	90	0	0.8	0	0	0.9	0	90	68	0.04	6	B	
	65	1976	4	13	23	10	9.330	17.992	-66.838	18.2	0.6D	2.4	90	0	1.0	0	0	3.0	0	90	68	0.10	6	D	
	66	1976	4	14	14	11	15.920	18.122	-67.021	16.5	2.7D	0.7	90	0	1.0	0	0	1.8	0	90	68	0.15	11	B	
	67	1976	4	16	19	9	42.470	18.105	-67.305	109.6	2.3D	4.6	90	0	1.8	0	0	1.7	0	90	68	0.16	9	D	
	68	1976	4	17	14	41	23.200	17.995	-67.113	15.0	1.4D	2.7	90	0	1.6	0	0	2.6	0	90	68	0.12	6	D	
	69	1976	4	18	14	44	43.890	17.924	-67.191	7.5	1.1D	1.2	90	0	2.2	0	0	0.9	0	90	68	0.11	6	C	
	70	1976	4	19	21	59	3.870	18.691	-66.509	27.4	1.9D	1.6	90	0	0.7	0	0	1.1	0	90	68	0.14	10	C	
	71	1976	4	20	14	1	26.020	17.904	-66.869	29.1	2.1D	1.6	90	0	0.6	0	0	0.7	0	90	68	0.13	10	C	
	72	1976	4	24	10	30	13.670	18.009	-67.022	2.7	2.2D	1.4	90	0	1.6	0	0	2.4	0	90	68	0.20	8	C	
	73	1976	4	24	11	8	43.310	17.998	-67.023	4.0	2.3D	2.0	90	0	2.0	0	0	2.6	0	90	68	0.19	7	D	
	74	1976	4	24	11	39	57.540	18.009	-67.042	4.8	2.2D	1.2	90	0	1.6	0	0	1.8	0	90	68	0.17	9	C	
	75	1976	4	26	12	1	16.760	18.687	-67.439	25.3	1.5D	1.9	90	0	1.9	0	0	1.6	0	90	68	0.09	6	D	
	76	1976	4	28	23	52	59.660	18.192	-67.196	5.1	1.1D	1.1	90	0	2.4	0	0	1.4	0	90	68	0.19	7	D	
	77	1976	4	30	5	5	47.890	17.843	-67.161	7.6	2.6D	2.4	90	0	3.1	0	0	1.2	0	90	68	0.17	9	D	
	78	1976	5	1	8	38	8.490	17.973	-66.959	16.8	1.1D	.....	90	..	0.5	0	0	0.5	0	90	68	0.05	5	C	
	79	1976	5	6	15	17	2.730	18.229	-66.952	17.1	1.4D	0.3	90	0	0.2	0	0	1.6	0	90	68	0.08	9	B	
	80	1976	5	8	8	53	10.590	17.911	-67.091	5.1	2.1D	1.1	90	0	1.5	0	0	1.0	0	90	68	0.17	9	C	
	81	1976	5	8	10	57	3.770	18.556	-66.858	22.7	2.8D	1.3	90	0	0.5	0	0	1.3	0	90	68	0.14	11	C	
	82	1976	5	12	22	4	32.900	17.970	-67.030	5.8	1.3D	3.0	90	0	1.8	0	0	1.7	0	90	68	0.16	8	D	
	83	1976	5	14	16	39	51.240	18.077	-67.273	13.5	1.4D	1.2	90	0	1.4	0	0	2.4	0	90	68	0.15	8	C	
	84	1976	5	15	10	47	26.470	18.021	-67.085	15.3	1.1D	0.3	90	0	0.3	0	0	0.4	0	90	68	0.04	7	B	
	85	1976	5	15	16	27	11.100	18.748	-67.250	27.7	2.4D	2.1	90	0	1.6	0	0	0.9	0	90	68	0.13	8	D	
	86	1976	5	17	21	30	45.740	18.140	-67.486	23.8	2.4D	2.0	90	0	0.8	0	0	3.5	0	90	68	0.20	11	C	
	87	1976	5	21	7	37	5.530	17.843	-66.818	8.8	1.6D	3.4	90	0	1.2	0	0	4.8	0	90	68	0.17	9	D	
	88	1976	5	21	22	59	5.870	18.030	-66.796	14.4	0.8D	1.1	90	0	0.6	0	0	2.6	0	90	68	0.04	5	C	
	89	1976	5	22	7	11	3.560	18.606	-66.520	20.2	1.8D	1.3	90	0	0.5	0	0	4.4	0	90	68	0.12	11	C	
	90	1976	5	24	00	15	7.690	18.236	-66.953	25.5	0.9D	0.9	90	0	0.8	0	0	2.0	0	90	68	0.13	7	C	

Appendix C Catalog of Western Puerto Rico microseismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	M	Error ellipsoid axes a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	X	Rms (S)	No ob	Q	*
PR197	91	1976	5	24	5	7	21.160	18.159	-67.172	16.0	2.10	0.6	90	0	1.8	0	0	1.4	0	90	68	0.14	10	C	
	92	1976	5	25	7	43	50.040	18.972	-66.816	54.1	3.00	4.6	90	0	1.1	0	0	5.0	0	90	68	0.17	11	D	
	93	1976	5	25	12	57	34.130	18.094	-66.841	14.7	0.80	1.0	90	0	0.5	0	0	2.4	0	90	68	0.09	6	C	
	94	1976	5	26	5	20	50.710	17.859	-66.818	4.7	1.10	2.7	90	0	1.0	0	0	1.5	0	90	68	0.19	7	D	
	95	1976	5	27	7	12	22.240	18.511	-67.536	16.6	1.40	2.6	90	0	2.8	0	0	3.2	0	90	68	0.17	7	D	
	96	1976	5	28	12	29	20.410	17.900	-66.674	7.7	1.80	0.7	90	0	0.3	0	0	0.5	0	90	68	0.11	11	C	
	97	1976	5	28	18	48	24.940	17.914	-67.121	4.1	1.70	2.3	90	0	1.3	0	0	1.1	0	90	68	0.18	10	D	
	98	1976	5	29	3	7	54.320	17.838	-66.927	4.2	1.30	2.4	90	0	1.1	0	0	1.6	0	90	68	0.20	9	D	
	99	1976	5	29	9	5	22.430	18.034	-66.936	22.5	0.70	1.3	90	0	0.5	0	0	2.4	0	90	68	0.05	5	C	
	100	1976	5	30	11	4	3.210	18.287	-67.129	25.3	2.00	1.0	90	0	1.6	0	0	1.3	0	90	68	0.14	10	C	
	101	1976	5	30	11	6	25.060	18.249	-67.129	25.2	1.90	1.0	90	0	2.1	0	0	1.4	0	90	68	0.18	10	C	
	102	1976	5	31	10	34	19.460	17.919	-67.170	6.2	0.90	4.1	90	0	2.4	0	0	2.2	0	90	68	0.19	6	D	
	103	1976	5	31	11	58	9.790	18.250	-67.162	26.3	2.00	0.8	90	0	0.9	0	0	0.8	0	90	68	0.18	13	C	
	104	1976	6	1	1	17	12.320	18.382	-67.350	16.9	1.30	0.8	90	0	1.4	0	0	2.4	0	90	68	0.11	8	C	
	105	1976	6	1	3	15	5.650	17.833	-66.826	3.9	2.80	1.5	90	0	0.5	0	0	0.9	0	90	68	0.12	10	C	
	106	1976	6	1	3	56	5.420	17.845	-66.814	2.2	1.30	1.9	90	0	0.9	0	0	1.4	0	90	68	0.18	7	C	
	107	1976	6	1	11	44	17.360	17.828	-66.809	7.2	1.60	2.5	90	0	0.6	0	0	2.7	0	90	68	0.16	10	D	
	108	1976	6	3	3	48	49.890	17.801	-66.801	1.3	1.40	1.0	90	0	0.7	0	0	0.8	0	90	68	0.09	6	C	
	109	1976	6	3	9	4	14.650	18.179	-67.455	18.2	1.90	1.5	90	0	1.8	0	0	1.3	0	90	68	0.15	9	C	
	110	1976	6	4	21	19	29.980	18.125	-67.031	30.0	0.90	1.2	90	0	1.5	0	0	1.9	0	90	68	0.13	7	B	
	111	1976	6	6	5	28	46.950	18.121	-66.963	22.8	1.10	1.5	90	0	1.0	0	0	2.4	0	90	68	0.17	7	B	
	112	1976	6	8	20	12	0.440	18.071	-67.107	5.9	1.10	0.6	90	0	2.6	0	0	0.9	0	90	68	0.16	6	D	
	113	1976	6	11	7	29	10.750	18.056	-67.064	22.4	1.10	0.3	90	0	0.3	0	0	0.5	0	90	68	0.03	6	B	
	114	1976	6	11	10	27	9.320	18.043	-66.810	12.3	2.20	0.6	90	0	0.3	0	0	2.5	0	90	68	0.10	11	C	
	115	1976	6	16	16	35	30.830	18.751	-67.735	19.2	4.30	4.5	90	0	2.2	0	0	2.0	0	90	68	0.12	11	D	
	116	1976	6	17	1	17	3.340	18.033	-67.143	17.2	1.30	0.8	90	0	0.6	0	0	0.7	0	90	68	0.05	7	C	
	117	1976	6	22	00	58	39.650	18.904	-67.052	29.4	2.20	1.6	90	0	2.1	0	0	1.5	0	90	68	0.20	12	D	
	118	1976	6	22	1	2	37.910	18.913	-67.016	27.8	2.70	1.3	90	0	0.8	0	0	0.7	0	90	68	0.10	11	C	
	119	1976	6	22	1	7	11.250	18.938	-67.026	28.2	2.40	1.0	90	0	0.9	0	0	0.7	0	90	68	0.12	12	C	
	120	1976	6	22	2	57	48.500	18.900	-67.001	25.5	2.30	1.2	90	0	1.4	0	0	1.0	0	90	68	0.18	13	C	
	121	1976	6	23	00	11	40.910	18.773	-67.425	17.1	2.30	2.5	90	0	1.9	0	0	2.1	0	90	68	0.20	12	D	
	122	1976	6	23	7	48	22.970	18.166	-66.959	19.4	1.00	0.5	90	0	0.7	0	0	1.6	0	90	68	0.08	7	B	
	123	1976	6	25	14	26	31.530	18.693	-67.482	27.2	2.30	2.7	90	0	1.7	0	0	0.9	0	90	68	0.19	11	D	
	124	1976	6	25	15	28	38.970	18.046	-67.134	16.9	1.60	0.6	90	0	0.7	0	0	1.9	0	90	68	0.06	6	C	
	125	1976	6	27	00	48	4.270	18.294	-67.200	32.6	1.00	1.0	90	0	1.9	0	0	1.6	0	90	68	0.16	8	C	
	126	1976	6	28	10	28	47.680	18.052	-67.083	23.0	0.70	0.9	90	0	0.9	0	0	1.2	0	90	68	0.09	6	C	
	127	1976	6	29	5	10	21.830	18.082	-67.730	56.8	2.60	3.1	90	0	2.2	0	0	4.1	0	90	68	0.20	12	D	
	128	1976	6	30	2	5	59.890	18.012	-66.650	19.2	1.70	0.9	90	0	0.5	0	0	1.4	0	90	68	0.16	14	C	
	129	1976	6	30	3	25	7.630	18.076	-67.056	24.4	1.00	1.0	90	0	0.6	0	0	1.3	0	90	68	0.12	6	C	
	130	1976	6	30	19	9	27.340	18.387	-66.592	109.2	2.20	2.6	90	0	1.1	0	0	1.3	0	90	68	0.17	13	C	
	131	1976	7	1	6	32	32.250	18.105	-66.866	17.3	0.80	1.9	90	0	0.5	0	0	4.8	0	90	68	0.13	7	C	
	132	1976	7	4	00	59	20.240	18.877	-67.228	26.9	2.10	2.1	90	0	2.3	0	0	1.3	0	90	68	0.12	7	D	
	133	1976	7	4	8	39	13.950	18.303	-67.001	28.9	1.30	1.3	90	0	0.9	0	0	2.1	0	90	68	0.15	8	C	
	134	1976	7	4	22	53	43.420	17.838	-66.776	2.9	1.70	1.5	90	0	0.5	0	0	0.9	0	90	68	0.16	10	C	
	135	1976	7	5	3	49	55.040	18.363	-67.404	16.7	2.00	1.5	90	0	1.4	0	0	1.3	0	90	68	0.19	11	C	

Appendix C Catalog of Western Puerto Rico Microseismicity--Continued

Catalog Name	Index	Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	M	a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	X	Rms (S)	No ob	Q	*
PR197	136	1976	7	7	22	41	18.250	18.547	-67.363	92.0	2.2D	3.7	90	0	2.3	0	0	2.0	0	90	68	0.20	11	D	
	137	1976	7	8	20	51	39.650	18.376	-66.794	4.5	1.6D	0.6	90	0	0.6	0	0	0.9	0	90	66	0.10	7	B	
	138	1976	7	10	12	57	47.700	18.375	-67.419	14.5	2.0D	1.1	90	0	0.9	0	0	5.0	0	90	68	0.12	11	C	
	139	1976	7	11	4	35	8.710	17.827	-66.772	1.1	1.8D	1.2	90	0	0.5	0	0	0.9	0	90	66	0.18	10	C	
	140	1976	7	11	11	41	32.380	18.670	-67.485	17.0	3.0D	2.8	90	0	1.6	0	0	2.9	0	90	68	0.17	10	D	
	141	1976	7	13	6	5	4.660	17.843	-67.031	29.7	1.6D	0.9	90	0	0.5	0	0	0.4	0	90	68	0.09	10	C	
	142	1976	7	13	12	21	52.010	18.106	-67.032	26.4	1.2D	2.1	90	0	1.1	0	0	2.9	0	90	68	0.10	5	C	
	143	1976	7	13	20	22	21.180	18.300	-66.876	3.3	1.5D	0.6	90	0	0.5	0	0	1.3	0	90	68	0.17	11	C	
	144	1976	7	18	20	56	0.090	18.279	-67.123	21.6	1.8D	0.9	90	0	1.3	0	0	3.4	0	90	68	0.12	8	C	
	145	1976	7	18	23	52	7.000	18.681	-67.462	22.8	2.9D	3.1	90	0	3.4	0	0	1.7	0	90	68	0.19	9	D	
	146	1976	7	19	1	58	19.050	17.928	-66.962	0.4	2.0D	3.5	90	0	1.4	0	0	2.3	0	90	68	0.20	7	D	
	147	1976	7	21	4	51	48.490	18.037	-67.081	34.4	1.8D	0.6	90	0	0.8	0	0	1.5	0	90	68	0.11	13	C	
	148	1976	7	24	20	51	18.750	18.398	-67.571	4.5	2.8D	2.7	90	0	1.0	0	0	2.4	0	90	68	0.13	11	D	
	149	1976	7	27	21	53	54.690	18.147	-67.418	8.6	2.3D	0.9	90	0	3.6	0	0	5.0	0	90	68	0.05	6	D	
	150	1976	8	5	2	32	32.710	18.055	-67.139	15.6	0.8D	1.8	90	0	1.8	0	0	2.4	0	90	68	0.08	5	D	
	151	1976	8	5	2	32	56.150	18.076	-67.109	15.0	1.9D	0.8	90	0	0.8	0	0	1.8	0	90	68	0.13	9	C	
	152	1976	8	5	3	4	28.110	18.079	-67.122	16.4	2.4D	0.8	90	0	1.1	0	0	2.3	0	90	68	0.17	11	C	
	153	1976	8	8	00	41	37.880	18.043	-67.167	22.1	0.8D	1.1	90	0	1.0	0	0	1.3	0	90	68	0.09	6	C	
	154	1976	8	8	11	3	0.430	18.082	-67.152	15.0	1.7D	1.2	90	0	1.8	0	0	3.4	0	90	68	0.15	7	C	
	155	1976	8	14	4	22	52.370	17.934	-67.045	17.2	1.1D	0.9	90	0	0.3	0	0	0.5	0	90	68	0.04	6	C	
	156	1976	8	15	13	8	45.360	18.052	-66.811	13.1	2.4D	0.6	90	0	0.2	0	0	1.3	0	90	68	0.08	10	B	
	157	1976	8	16	4	15	49.160	18.601	-66.753	17.9	2.4D	0.9	90	0	0.4	0	0	1.7	0	90	68	0.10	11	C	
	158	1976	8	20	20	18	59.750	18.179	-67.055	20.3	1.4D	0.5	90	0	0.7	0	0	1.8	0	90	68	0.10	8	A	
	159	1976	8	21	18	33	16.330	18.558	-66.907	20.8	2.3D	1.3	90	0	0.6	0	0	1.3	0	90	68	0.12	10	C	
	160	1976	8	25	5	31	56.550	18.144	-67.338	28.6	1.2D	1.6	90	0	2.5	0	0	1.1	0	90	68	0.08	5	D	
	161	1976	8	25	14	24	16.270	17.776	-66.664	5.1	1.1D	1.7	90	0	2.1	0	0	1.3	0	90	68	0.08	5	D	
	162	1976	8	26	6	47	37.130	18.351	-67.286	13.8	2.0D	1.0	90	0	0.3	0	0	3.1	0	90	68	0.09	10	C	
	163	1976	8	27	10	34	3.630	18.545	-66.646	17.9	2.9D	0.8	90	0	0.4	0	0	1.3	0	90	68	0.11	11	C	
	164	1976	8	28	18	59	41.010	18.150	-66.814	8.7	1.4D	0.9	90	0	0.3	0	0	1.5	0	90	68	0.12	10	B	
	165	1976	8	29	4	38	14.970	18.778	-67.519	24.5	1.9D	1.5	90	0	1.4	0	0	1.0	0	90	68	0.11	9	C	
	166	1976	9	5	7	1	49.320	18.320	-67.054	11.1	1.0D	0.1	90	0	0.1	0	0	0.3	0	90	68	0.01	5	C	
	167	1976	9	7	18	8	15.290	18.648	-67.565	22.5	3.2D	2.8	90	0	1.1	0	0	1.1	0	90	68	0.09	9	D	
	168	1976	9	12	2	59	3.370	18.271	-67.161	24.7	2.7D	0.5	90	0	0.3	0	0	0.5	0	90	68	0.11	15	B	
	169	1976	9	13	14	5	21.430	18.559	-66.686	11.8	1.5D	2.2	90	0	1.7	0	0	1.8	0	90	68	0.07	6	D	
	170	1976	9	13	23	30	35.140	18.012	-66.570	13.4	1.7D	1.1	90	0	0.4	0	0	2.2	0	90	68	0.16	13	C	
	171	1976	9	14	22	53	27.500	17.950	-66.987	8.6	1.4D	1.0	90	0	0.5	0	0	0.7	0	90	68	0.04	6	C	
	172	1976	9	15	2	39	44.020	17.944	-66.986	11.5	1.2D	0.6	90	0	0.5	0	0	2.6	0	90	68	0.05	6	C	
	173	1976	9	15	14	49	30.820	18.128	-67.193	27.6	1.0D	2.8	90	0	1.6	0	0	2.8	0	90	68	0.09	5	D	
	174	1976	9	18	12	16	55.350	18.154	-66.819	23.7	0.8D	1.6	90	0	1.0	0	0	2.9	0	90	68	0.09	6	C	
	175	1976	9	18	14	30	16.170	17.862	-66.792	2.7	1.5D	0.6	90	0	0.3	0	0	0.7	0	90	68	0.09	9	C	
	176	1976	9	23	3	44	5.770	18.109	-67.044	17.2	1.6D	0.9	90	0	1.0	0	0	2.7	0	90	68	0.11	8	B	
	177	1976	10	7	6	4	3.190	18.225	-67.184	23.1	3.2D	0.8	90	0	0.6	0	0	1.3	0	90	68	0.19	13	B	
	178	1976	10	7	6	27	46.510	18.233	-67.158	21.8	1.6D	0.6	90	0	0.7	0	0	0.9	0	90	68	0.10	9	C	
	179	1976	10	7	10	33	52.900	18.226	-67.189	24.3	2.7D	0.5	90	0	0.4	0	0	0.7	0	90	68	0.10	11	B	
	180	1976	10	7	23	16	35.410	18.225	-67.183	23.5	2.8D	0.3	90	0	0.3	0	0	0.5	0	90	68	0.08	12	B	

Appendix C Catalog of western Puerto Rico Microseismicity--Continued

Catalog Name	Catalog Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	M	Error ellipsoid axes a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	%	Rms (S)	No ob	Q	*
PR197	181	1976	10	8	5	40	0.380	18.232	-67.157	20.5	1.6D	1.4	90	0	2.8	0	0	1.5	0	90	68	0.19	7	D	
	182	1976	10	9	6	21	10.520	18.009	-67.040	21.7	0.8D	2.8	90	0	1.2	0	0	2.4	0	90	68	0.15	6	D	
	183	1976	10	9	7	27	45.830	18.031	-67.030	17.1	0.5D	1.0	90	0	0.5	0	0	1.2	0	90	68	0.04	5	C	
	184	1976	10	10	12	45	3.470	18.228	-67.190	24.6	3.2D	0.6	90	0	0.5	0	0	1.1	0	90	68	0.13	12	B	
	185	1976	10	11	23	38	25.770	18.223	-67.165	22.5	2.2D	0.7	90	0	0.8	0	0	0.5	0	90	68	0.15	15	C	
	186	1976	10	11	23	48	45.560	18.221	-67.164	20.7	2.3D	0.8	90	0	1.1	0	0	0.9	0	90	68	0.19	15	C	
	187	1976	10	12	00	5	20.070	18.229	-67.206	24.3	1.5D	0.5	90	0	1.2	0	0	0.6	0	90	68	0.11	9	C	
	188	1976	10	12	4	46	30.230	18.611	-67.456	14.1	2.8D	2.9	90	0	1.7	0	0	3.0	0	90	68	0.20	12	D	
	189	1976	10	12	23	31	3.470	18.958	-66.711	41.5	2.0D	2.3	90	0	0.8	0	0	3.4	0	90	68	0.12	10	C	
	190	1976	10	14	6	45	20.360	17.859	-66.807	2.7	1.8D	1.5	90	0	0.6	0	0	1.0	0	90	68	0.16	10	C	
	191	1976	10	14	10	13	53.640	18.235	-67.232	26.1	1.3D	0.4	90	0	1.5	0	0	0.5	0	90	68	0.07	7	C	
	192	1976	10	14	10	51	3.090	17.943	-66.994	9.3	0.8D	0.9	90	0	0.5	0	0	3.3	0	90	68	0.08	6	C	
	193	1976	10	15	16	45	16.180	17.988	-67.115	14.2	1.3D	0.5	90	0	0.5	0	0	0.8	0	90	68	0.06	8	C	
	194	1976	10	17	18	54	17.670	17.815	-66.780	2.8	1.4D	1.1	90	0	0.6	0	0	1.2	0	90	68	0.08	6	C	
	195	1976	10	18	4	9	29.000	18.147	-66.937	26.1	0.9D	0.5	90	0	0.3	0	0	0.8	0	90	68	0.06	7	B	
	196	1976	10	19	1	41	18.040	18.649	-67.502	12.0	2.1D	3.0	90	0	2.0	0	0	2.3	0	90	68	0.20	9	D	
	197	1976	10	22	5	25	22.640	17.827	-66.778	2.7	1.2D	0.5	90	0	0.2	0	0	0.5	0	90	68	0.04	7	C	
	198	1976	10	27	22	27	5.370	18.285	-66.511	109.2	1.9D	4.4	90	0	1.5	0	0	1.9	0	90	68	0.17	10	C	
	199	1976	10	31	13	30	33.830	17.967	-67.013	12.2	0.8D	1.2	90	0	0.4	0	0	1.0	0	90	68	0.04	5	C	
	200	1976	10	31	22	10	20.520	18.161	-67.324	17.1	1.7D	0.9	90	0	1.1	0	0	2.2	0	90	68	0.09	8	C	
	201	1976	11	2	20	48	3.300	18.663	-66.815	22.9	1.6D	1.5	90	0	1.0	0	0	4.8	0	90	68	0.19	10	C	
	202	1976	11	6	1	46	8.390	18.049	-67.080	22.7	0.4D	1.4	90	0	1.4	0	0	1.9	0	90	68	0.14	6	C	
	203	1976	11	7	00	44	45.740	18.403	-67.657	11.7	1.8D	2.1	90	0	0.9	0	0	2.7	0	90	68	0.18	10	C	
	204	1976	11	9	7	25	24.120	17.876	-67.194	0.8	1.7D	1.2	90	0	1.4	0	0	1.4	0	90	68	0.17	8	C	
	205	1976	11	10	5	7	3.900	17.823	-66.799	2.2	1.1D	0.7	90	0	0.4	0	0	0.6	0	90	68	0.06	6	C	
	206	1976	11	16	00	50	46.460	17.995	-67.045	5.9	1.8D	2.0	90	0	1.6	0	0	1.6	0	90	68	0.20	9	D	
	207	1976	11	20	9	17	2.020	18.576	-66.997	24.3	1.6D	0.8	90	0	0.6	0	0	0.7	0	90	68	0.11	13	C	
	208	1976	11	20	14	41	28.740	18.687	-67.373	26.7	2.1D	2.6	90	0	2.1	0	0	1.2	0	90	68	0.17	9	D	
	209	1976	11	21	11	3	10.410	18.199	-67.233	15.3	1.6D	0.9	90	0	1.8	0	0	1.9	0	90	68	0.19	8	C	
	210	1976	11	22	19	38	40.140	18.042	-67.133	14.7	1.0D	1.2	90	0	1.1	0	0	1.4	0	90	68	0.05	5	C	
	211	1976	11	23	1	43	15.040	18.037	-67.132	15.9	0.8D	0.9	90	0	0.8	0	0	1.0	0	90	68	0.04	5	C	
	212	1976	11	25	21	14	7.210	18.238	-66.965	22.4	2.1D	0.6	90	0	0.7	0	0	1.6	0	90	68	0.14	12	A	
	213	1976	11	25	22	38	23.860	18.194	-67.413	54.4	2.4D	2.1	90	0	1.6	0	0	1.9	0	90	68	0.16	12	D	
	214	1976	11	27	18	35	24.250	18.000	-67.037	6.1	1.8D	1.2	90	0	1.1	0	0	1.2	0	90	68	0.09	6	C	
	215	1976	11	29	4	48	23.760	17.843	-66.931	8.2	1.1D	0.2	90	0	.....	...	..	0.1	0	90	68	0.08	5	C	
	216	1976	12	1	00	37	58.770	18.018	-67.122	5.0	1.6D	0.5	90	0	1.2	0	0	0.4	0	90	68	0.05	5	C	
	217	1976	12	2	9	40	39.380	18.001	-66.783	14.8	1.4D	1.2	90	0	0.4	0	0	2.1	0	90	68	0.16	11	C	
	218	1976	12	5	11	28	1.870	18.805	-67.104	26.8	3.7D	2.7	90	0	2.6	0	0	1.5	0	90	68	0.20	11	D	
	219	1976	12	6	1	14	23.320	17.766	-67.008	39.7	1.2D	2.9	90	0	1.1	0	0	3.3	0	90	68	0.12	6	D	
	220	1976	12	6	8	4	48.230	18.110	-66.995	23.6	0.9D	1.1	90	0	1.3	0	0	2.0	0	90	68	0.10	6	B	
	221	1976	12	9	2	7	26.490	18.936	-67.493	28.1	2.7D	1.5	90	0	1.1	0	0	0.8	0	90	68	0.11	12	C	
	222	1976	12	9	19	22	0.290	17.994	-67.118	18.1	1.0D	0.9	90	0	1.0	0	0	1.1	0	90	68	0.09	6	C	
	223	1976	12	10	5	18	41.960	18.060	-67.091	29.1	1.4D	1.8	90	0	1.8	0	0	2.4	0	90	68	0.20	7	C	
	224	1976	12	12	6	32	29.700	18.480	-67.105	23.2	1.7D	2.4	90	0	2.2	0	0	2.2	0	90	68	0.15	7	D	
	225	1976	12	13	1	30	49.780	17.980	-66.735	12.2	2.2D	0.9	90	0	0.3	0	0	2.0	0	90	68	0.10	10	C	

Appendix C Catalog of western Puerto Rico Microseismicity--Continued

Catalog Name	Index	Origin time (UTC) Yr	Mo	D	H	Min	S	North latitude (deg)	East longitude (deg)	Focal depth (km)	M	Error ellipsoid axes a(km)	Tr	Pl	b(km)	Tr	Pl	c(km)	Tr	Pl	%	Rms (S)	No ob	Q	*
PR197	226	1976	12	17	22	16	16.380	17.949	-66.915	6.5	0.5D	0.6	90	0	0.1	0	0	0.2	0	90	68	0.05	5	C	
	227	1976	12	20	13	21	18.120	18.226	-67.118	24.5	2.0D	1.6	90	0	1.0	0	0	0.9	0	90	68	0.12	9	C	
	228	1976	12	21	13	36	15.170	17.949	-67.043	16.3	0.8D	0.7	90	0	0.4	0	0	0.8	0	90	68	0.05	6	C	
	229	1976	12	22	2	25	44.410	18.104	-67.241	11.9	2.5D	0.5	90	0	1.0	0	0	2.6	0	90	68	0.10	10	C	
	230	1976	12	23	20	4	9.240	18.548	-66.774	24.3	2.1D	1.5	90	0	0.7	0	0	1.5	0	90	68	0.17	11	C	
	231	1976	12	24	6	36	53.040	18.164	-67.315	30.4	1.0D	1.0	90	0	2.4	0	0	1.8	0	90	68	0.07	6	D	
	232	1976	12	25	8	45	13.100	18.907	-66.876	26.2	2.2D	2.0	90	0	1.2	0	0	1.6	0	90	68	0.18	13	C	
	233	1976	12	25	9	00	25.610	18.926	-66.674	25.1	2.7D	2.3	90	0	1.7	0	0	1.9	0	90	68	0.20	12	D	
	234	1976	12	26	00	18	37.220	17.815	-66.767	0.4	2.9D	2.0	90	0	0.7	0	0	1.5	0	90	68	0.17	10	C	
	235	1976	12	26	00	39	57.850	18.003	-67.006	9.2	0.6D	0.8	90	0	0.3	0	0	1.3	0	90	68	0.03	5	C	
	236	1976	12	26	7	58	17.840	18.373	-67.257	24.2	1.9D	2.0	90	0	2.9	0	0	1.3	0	90	68	0.19	10	D	
	237	1976	12	26	8	4	9.000	18.391	-67.270	24.4	1.2D	2.2	90	0	2.7	0	0	1.1	0	90	68	0.18	9	D	
	238	1976	12	26	11	25	2.980	18.367	-67.226	24.4	1.1D	0.8	90	0	2.0	0	0	1.0	0	90	68	0.11	7	C	
	239	1976	12	29	2	29	52.200	18.543	-66.792	80.3	2.3D	3.3	90	0	1.4	0	0	2.5	0	90	68	0.15	9	D	
	240	1977	1	2	2	14	20.630	17.999	-67.008	0.4	2.1D	0.7	90	0	0.3	0	0	1.0	0	90	68	0.15	9	C	
	241	1977	1	2	3	39	34.000	18.061	-67.103	18.1	1.8D	0.7	90	0	0.6	0	0	0.6	0	90	68	0.09	11	C	
	242	1977	1	2	4	23	42.210	18.099	-66.973	7.6	2.1D	0.2	90	0	0.9	0	0	1.2	0	90	68	0.07	11	B	
	243	1977	1	3	2	47	33.380	17.980	-66.510	7.8	1.0D	2.2	90	0	1.1	0	0	1.7	0	90	68	0.07	7	C	
	244	1977	1	3	6	8	37.980	18.163	-67.291	19.4	2.2D	1.2	90	0	1.9	0	0	1.2	0	90	68	0.18	10	C	
	245	1977	1	4	14	10	48.340	18.694	-67.394	25.3	1.9D	3.1	90	0	1.5	0	0	1.1	0	90	68	0.10	7	D	
	246	1977	1	5	13	20	13.320	18.185	-67.474	19.0	3.1D	2.1	90	0	4.0	0	0	1.9	0	90	68	0.17	8	D	
	247	1977	1	7	5	45	5.410	18.646	-66.742	75.1	2.1D	2.1	90	0	0.9	0	0	1.9	0	90	68	0.18	15	C	
	248	1977	1	8	17	12	51.230	17.887	-66.911	0.2	1.8D	1.0	90	0	0.3	0	0	0.9	0	90	68	0.10	9	C	
	249	1977	1	8	20	50	26.640	18.130	-66.987	18.5	1.0D	0.9	90	0	0.7	0	0	1.8	0	90	68	0.13	8	C	
	250	1977	1	9	5	49	24.120	17.784	-66.763	15.5	2.7D	0.9	90	0	0.4	0	0	3.9	0	90	68	0.09	11	C	
	251	1977	1	10	20	38	16.090	18.448	-66.755	17.8	1.6D	1.1	90	0	0.9	0	0	1.9	0	90	68	0.06	6	C	
	252	1977	1	12	7	11	11.400	17.923	-66.977	6.3	1.2D	2.3	90	0	1.1	0	0	0.9	0	90	68	0.06	5	D	
	253	1977	1	14	4	26	14.630	18.168	-67.247	105.0	2.2D	2.3	90	0	1.3	0	0	1.6	0	90	68	0.12	12	D	
	254	1977	1	16	6	23	38.920	18.159	-67.573	11.7	1.9D	1.8	90	0	1.7	0	0	1.8	0	90	68	0.17	11	C	
	255	1977	1	17	15	58	46.290	18.124	-66.984	17.6	1.6D	0.9	90	0	0.4	0	0	1.6	0	90	68	0.08	7	C	
	256	1977	1	17	16	00	4.470	18.107	-66.986	22.4	1.0D	1.6	90	0	1.1	0	0	2.7	0	90	68	0.16	6	C	
	257	1977	1	19	4	9	6.260	17.891	-66.939	8.2	1.0D	2.5	90	0	0.6	0	0	3.0	0	90	68	0.12	7	D	
	258	1977	1	21	00	1	7.230	18.835	-67.269	25.8	2.3D	1.3	90	0	1.4	0	0	1.0	0	90	68	0.13	11	C	
	259	1977	1	21	16	52	16.690	18.083	-67.036	13.5	0.9D	0.6	90	0	1.2	0	0	2.3	0	90	68	0.12	7	B	
	260	1977	1	24	21	48	59.740	18.556	-67.571	10.4	2.0D	2.3	90	0	1.3	0	0	3.1	0	90	68	0.09	7	D	
	261	1977	1	26	2	32	15.620	17.786	-66.784	4.5	1.2D	1.3	90	0	0.9	0	0	0.7	0	90	68	0.06	6	C	
	262	1977	1	27	6	7	36.730	18.830	-67.391	24.4	2.4D	1.0	90	0	1.2	0	0	0.9	0	90	68	0.07	9	C	
	263	1977	1	27	7	35	36.490	18.576	-67.418	15.1	2.1D	1.8	90	0	1.7	0	0	2.2	0	90	68	0.19	11	D	
	264	1977	1	28	2	19	21.230	18.682	-66.791	70.1	2.3D	3.0	90	0	1.3	0	0	2.0	0	90	68	0.20	12	D	
	265	1976	6	21	23	10	45.970	18.217	-66.513	137.2	2.0D	3.0	90	0	1.2	0	0	1.1	0	90	68	0.14	13	C	
	266	1976	8	16	22	13	7.260	18.076	-67.824	128.1	3.2D	2.4	90	0	0.5	0	0	1.3	0	90	68	0.05	10	C	
	267	1976	9	13	1	59	5.790	17.907	-67.931	154.9	2.8D	3.7	90	0	3.2	0	0	2.8	0	90	68	0.19	11	D	
	268	1976	10	12	3	31	31.580	18.146	-67.315	141.9	2.2D	1.6	90	0	1.1	0	0	0.7	0	90	68	0.08	9	C	

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