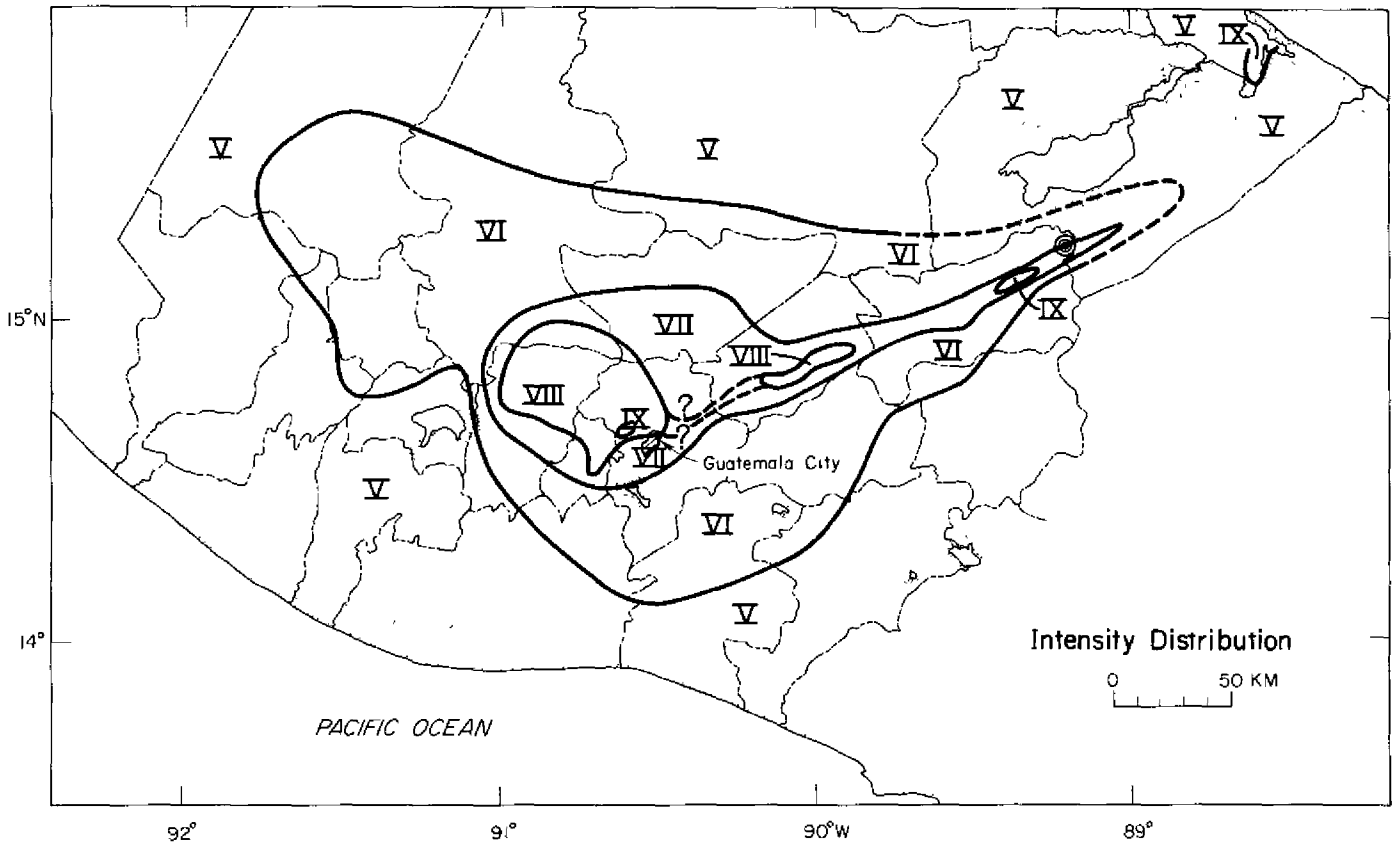

FIGURE 43.—Modified Mercalli intensity distribution in Guatemala from the main event. Circle indicates epicenter location of the February 4 earthquake; dashed line indicates approximate isoseismal. (Base map modified from Guatemala Instituto Geográfico Nacional, 1974, 1:500,000.)

the Departments of Chimaltenango, Guatemala, and lower Quiché. These regions of the country are the highlands of Guatemala. The affected region of 51- to 100-percent damage covers a surface area of approximately 8,725 km². There are two well-defined areas of maximum damage; one follows a trend parallel to the Motagua fault located in the Departments of Izabal, Zacapa, and El Progreso. A gap is found between the 4 and 2 contours for nearly 40 km. Within the next 35 km there is another concentration of high damage (fig. 45). The damage pattern diminished rapidly to the west into the state of Totonicapán.

TABLE 11.—*Damage to adobe-type structures*

Scale [1]	Percent damage	Damage area (km²)
2 and higher	51–75	8,725
3 and higher	76–90	2,825
4	91–100	1,720

[1] Scale values taken from figure 45

A number of cracks, fractures, and short fault scarps were found due west of Guatemala City in the Mixco area. Damage decreases more rapidly to the east than to the west of the zone of strongest shaking. The areas damaged for different percentiles of collapsed adobe houses are given in table 11.

Adobe structures are apt to collapse more easily than bajareque (Husid and others, this report) and wooden-type construction. The latter construction is found throughout the Motagua River Valley in the lowland near the coastal area of Guatemala. In Puerto Barrios and in Santo Tomás, many of the houses are built of wood. The wharf of Puerto Barrios collapsed because of structural failure and possible ground compaction (Ray Wilson, oral commun., 1976) (fig. 47). There was no damage to well-built structures in the port of Santo Tomás, 5 km south of Puerto Barrios. In the port of Santo Tomás, a number of ground cracks were observed, and ground-level changes of 10 to 15 cm in the maritime port were due to ground compaction.

Near Puerto Barrios, mud spouts occurred during the main earthquake. The damage in this region to wood-frame and adobe structures was minimal.

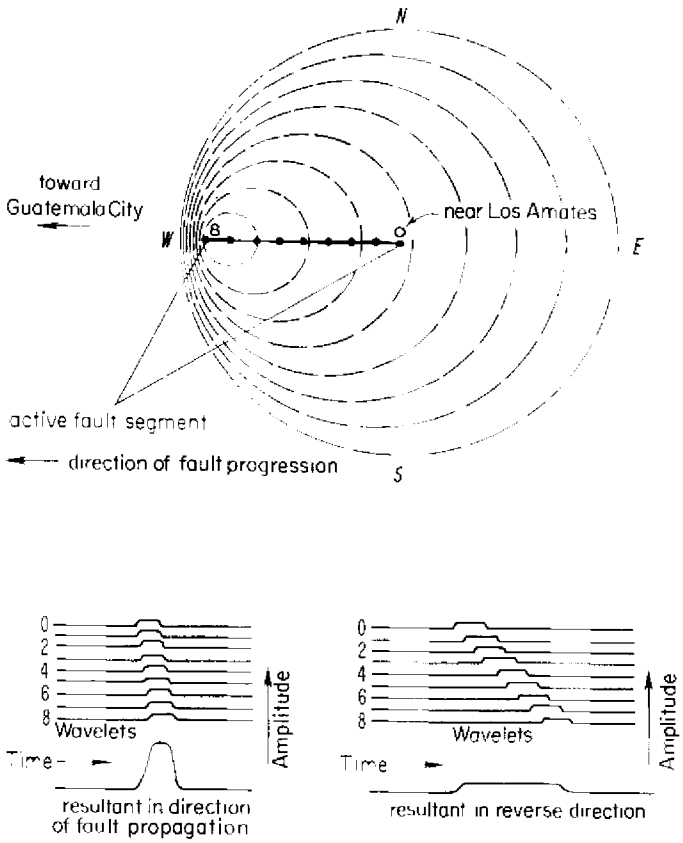

FIGURE 44.—Schematic of slip progression and its effect on wave amplitudes and shapes due to a moving source (modified from Benioff, 1955). Fault propagation from east, near Los Amates, to west, toward Guatemala City.

The pattern of adobe damage (fig. 45) is similar to the intensity distribution shown in figure 43. The similarity suggests that more energy was released to the west than to the east. It also suggests that seismic energy was released along and near the known fault zone of the Motagua fault. The maximum concentration of damage, mostly in the Department of Chimaltenango, is suggestive of a constructive interference of seismic waves due to a moving dislocation.

INTENSITIES IN GUATEMALA CITY

The distribution of earthquake intensity was investigated by canvassing Guatemala City in a manner similar to the way in which the Republic of Guatemala was canvassed. In the process of canvassing Guatemala City, data were obtained from a representative number of questionnaires solicited from each of the 16 zones into which the city is divided. A total of 1,050 questionnaires was completed and collected.

A map of intensity distribution for Guatemala City associated with the earthquake is now being prepared. The following cursory comments are the preliminary result of our fieldwork.

The maximum Modified Mercalli intensity in the city was IX, as shown by the partial collapse of reinforced-concrete structures, and there were pockets of high intensities in different zones of the city. A cursory examination of the questionnaires shows that some of the localized high intensities may be related to possible ground-amplification effects of seismic waves. Similar findings were reported elsewhere on a seismic-zonation study in Lima, Peru (Espinosa and others, 1976).

A number of chimneys cracked and collapsed in different suburbs of the city (fig. 48). The variations of the intensity ratings in the city proper varied from VI to IX. A number of wells showed an increase in temperature of more than 2° C, and their water level changed drastically, sometimes more than 60 cm, due to the February 4 earthquake. In the northern part of the city, damage to adobe-type construction was intense. Also, throughout the city, there were a number of damaged reinforced-concrete structures (Husid and others, this report). A number of landslides occurred to the northwest in the Colonia 1° de Julio, Zone 19, on the Barranco de las Guacamayas. The barrancos have an almost vertical drop of nearly 90 m. Figure 49 shows the head of a landslide in the area, at approximately long 90°33.5′ W., lat 14°40.6′ N.

In Zone 7, 13 Calle B. No. 31–14, a one-story brick house sustained a large amount of damage from a ground crack, possibly a small fault with a north-south trend, which crossed through the house. This ground crack could be traced very easily through the suburb, across damaged streets and houses. In other zones, such as Zone 19, 8 Avenue No. 6–96 there was considerable damage because of ground failure. In Zone 11, 8 Calle No. 20–62, Colonia Mirador, there was moderate damage to a one-story brick house. These examples show the damage that can be caused by faulting in the immediate vicinity or below some of these houses in Guatemala City.

INTENSITIES IN NEIGHBORING COUNTRIES

The Modified Mercalli isoseismal V covered an area from Ilepango, Izales, and San Salvador in El Salvador to Santa Barbara, San Pedro Sula, and Puerto Cortes in Honduras. In Tegucigalpa, an intensity rating of IV was assigned. To the north,

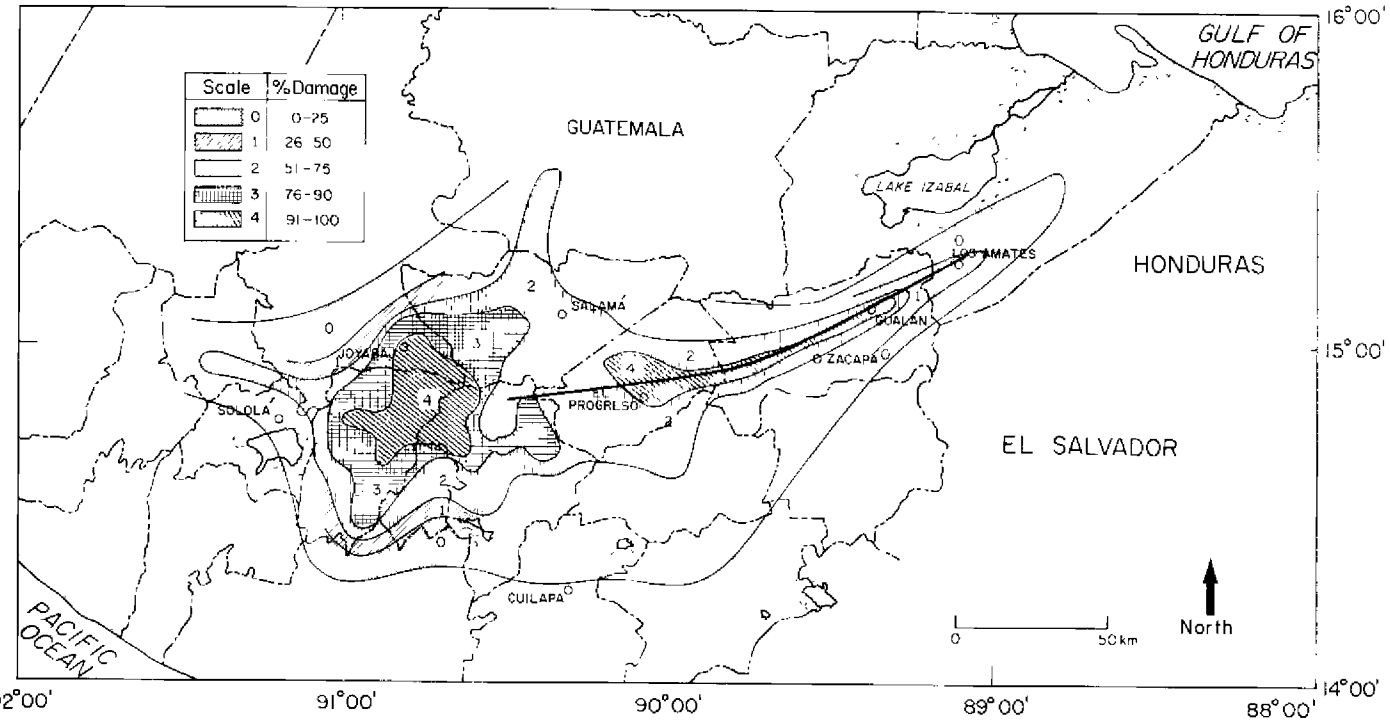

FIGURE 45.— Contour map showing damage to adobe-type structures in Guatemala owing to the February 4 earthquake. See figure 1 for Department names. (Base map modified from Guatemala Instituto Geográfico Nacional, 1974, 1:500,000.)

Belice had a IV and Mexico City a IV rating. Poctun in the Guatemalan northern territory had an intensity of V. The total felt area for an intensity V or higher was 93,125 km^2.

The earthquake of 1773, called the Santa Marta earthquake, caused extensive damage in the Guatemalan highlands down to El Salvador. The February 4 earthquake and the Santa Marta earthquake affected similar areas in Guatemala and El Salvador, but there was no damage to El Salvador from the February 4 earthquake

GROUND MOTION AT INTERMEDIATE DISTANCES

Strong ground displacements were recorded on a seismoscope in Guatemala City (Knudson, this report), but, unfortunately, no accelerographs were operational in the area at the time of the earthquake.

Strong ground motions were experienced in the Mixco area, in particular at the Licorera Mixco, where a large oil-fired boiler was displaced horizontally a maximum of 41 cm.

In La Colonia 1° de Julio, a northwestern suburb of Guatemala City, a large water tank sustained damage to its back bracings at the upper level (nearly 12 m from the ground). The shear bracings also were bent. The water tank sustained damage at a height of 4 m from the bottom of the tank and 16 m from the ground, where the bolts tying the steel walls of the water tank were sheared and water leaked out.

In Guatemala City, in the chemistry building of the ICAITI (see Glossary) complex, a large machine weighing 1,298 kg was displaced 7 cm horizontally. To the southeast of the city in Zone 10, in the Herrera's grounds, four medium-sized marble statutes were thrown 40 cm from their stands (fig. 50). There were some reports that hanging lamps dented the ceilings of homes and that outside hanging lamps left a fan of dents on the walls.

In the maritime port of Santo Tomás, a large upright unloading cargo crane weighing 60 tons was displaced from its rails 5 cm in a northeasterly direction. This port is northeast of Los Amates.

SOURCE PARAMETERS FROM FIELD OBSERVATIONS

Many major earthquakes have occurred in close association with major faults; as a result, a number of empirical relations that correlate magnitude, length of surface faulting, fault displacement, and magnitude have been derived. King and Knopoff (1968) developed the following relation:

$$\log L\bar{u}^2 = 2.24\ M - 4.99. \qquad (1)$$