# TECTONIC SIGNIFICANCE OF SURFACE FAULTING RELATED TO THE 4 FEBRUARY 1976 GUATEMALA EARTHQUAKE

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## Introduction

The devastating earthquake (surface wave magnitude $M_S = 7.5$) that struck Guatemala at 0303 hours local time on 4 February 1976 took an estimated 23,000 lives, caused 74,000 reported injuries, and left more than 1 million people homeless in a country with a total population of about 5.5 million. From a scientific viewpoint, the Guatemala earthquake sequence is particularly noteworthy because it was accompanied by the most extensive surface faulting in the western hemisphere since the 1906 San Francisco earthquake. This permits evaluation of the damage distribution relative to the earthquake source and provides critical new information on the present style of tectonic deformation in northern Central America. The only previous event for which a detailed geologic study of surface faulting was made in the 450-year seismic history of Central America was the magnitude 6.2 earthquake of 23 December 1972 that destroyed Managua, Nicaragua (Brown and others, 1973).

This article summarizes the results of geologic field investigations of the surface faults and briefly considers their relation to the epicenters of the main shock and larger aftershocks and to the distribution of damage. On the basis of the preliminary data, a tentative interpretation of the mechanism of the earthquake, within the framework of plate tectonic theory, is proposed. It undoubtedly will require some modification or revision as additional results of investigations of this major seismic event become available.

## Motagua Fault Surface Ruptures

The main fault along which the destructive earthquake of 4 February and its associated surface displacement occurred was identified along the southern margin of the Motagua valley and the mountainous area west of the valley (Fig. 1). The eastern part of this major fault within the Motagua valley has been named the Motagua fault (Dengo and Bohnenberger, 1969; Instituto Geográfico Nacional, 1969), and this name is herein applied to all of the fault trace that was activated during the earthquake.

Ground breakage was observed in a nearly continuous, well-defined line for 230 kilometers extending from near Quebradas in the lower Motagua valley on the east to about 10 km east of Patzaj on the west (Figs. 2 to 4). At the closest point, the fault is 25 km north of the center of Guatemala City. The rupture could not be identified farther to the west because young volcanic deposits and earthquake-triggered slope failures effectively mask the fault-related surface fractures. At the east end, the fault trace is obscured in the lower Motagua valley by swamps and dense tropical vegetation. However, the aftershock distribution suggests that the faulting probably does not extend more than a few tens of kilometers beyond the observed limits of the surface ruptures.

The fault trace is arcuate and convex to the south with a gradual change in average strike from N. 65° W. at the east end to N. 80° W. at the west end. It consists of right-stepping en echelon fractures and connecting low compressional ridges that locally form the "mole tracks" characteristic of strike-slip faults. Individual fractures within the zone are oriented at angles of up to 35° to the fault trace and have the northeasterly azimuths to be expected for sinistral slip. The amount of opening or separation perpendicular to the fracture walls is negligible for those that roughly