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LETTERS TO THE EDITOR

PEAK ACCELERATION FROM STRONG-MOTION RECORDS: A POSTSCRIPT

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In a recent paper, Boore *et al.* (1980) used a regression analysis of strong-motion data to derive relations giving peak amplitudes as a function of distance to the fault surface for earthquakes in the three magnitude ranges 5.0 to 5.7, 6.0 to 6.4, and 7.1 to 7.6 (the peculiar limits of the ranges were dictated by the magnitudes of the available events). The data came from earthquakes before 1976. Additions to the strong-motion data set from several recent earthquakes (Table 1) have prompted us to test the regression curves of Boore *et al.* (1980) for peak horizontal acceleration recorded at the base of small structures (less than 3 stories high) against the new data. The comparison, presented in Figure 1, shows generally good agreement between the new data and the predictions of the mean line from the regression

TABLE 1

EARTHQUAKES PROVIDING DATA USED IN THIS PAPER

Date (y/m/d)	Origin Time (h:min UTC)	Location	Magnitude
79/10/15	23:19	Imperial Valley, California	5.0 (M_L, PAS)
78/08/13	22:54	Santa Barbara, California	5.1 (M_L, PAS)
80/01/24	19:00	Livermore Valley, California	5.5 (M_L, BRK)
80/01/27	02:33	Livermore Valley, California	5.8 (M_L, BRK)
79/08/06	17:05	Coyote Lake, California	5.9 (M_L, BRK)
79/10/15	23:17	Imperial Valley, California	6.6 (M_L, PAS)
79/02/28	21:27	St. Elias, Alaska	7.1 (M_S, NEIS)

analysis. The magnitude 6 data (all of which are from the Imperial Valley earthquake) are in almost perfect agreement with the prediction intervals. The magnitude 5 data (Figure 1a) indicate that the prediction intervals based on the prior data are too broad. Data from the Horse Canyon, California, earthquake of 25 February 1980, not shown for the sake of clarity, substantiate this.

Even with smaller prediction intervals, however, a large uncertainty still exists in the prediction of peak acceleration. One factor contributing to the scatter is suggested by the data from the Livermore Valley earthquakes. We plotted the ratio of peak accelerations from both events, recorded at the same site (without regard to structure size) and corrected for distance, against the mean azimuth from the closest points on the rupture surfaces to the recording site (Figure 2). Using the same sites should eliminate variations due to site effects. The results show a strong dependence on azimuth and are most easily interpreted as the result of directivity (Boore and Joyner, 1978). A similar dependence is suggested by plots of the residuals about the regression line in Figure 1. The results in Figure 2 are consistent with a simple model of rupture in which the 1/24 event ruptured to the southeast and the 1/27 event ruptured to the northwest. If the directivity persists at lower frequencies (as might be seen, e.g., in peak velocities), the M_L determined from instruments at Berkeley (azimuth $\approx 290°$) might be biased to low and high values for the 1/24 and 1/27 events, respectively.

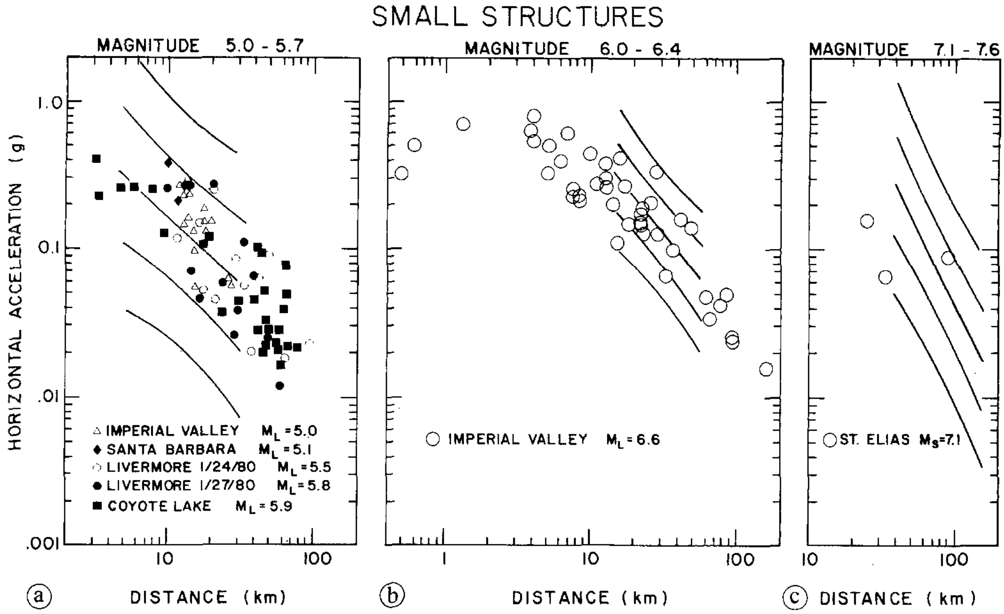

FIG. 1. Peak horizontal acceleration against closest distance to fault, compared with the mean regression line and 70 and 95 per cent prediction intervals (inner and outer pair, respectively) given by Boore *et al.* (1980). Distance range used in regression analysis was determined by the requirement of sufficient data and the absence of operational stations that did not trigger in the distance range indicated. The range of magnitudes shown at the *top* of each figure are the ranges used in the regression analysis. The magnitude range of the new data can be obtained from Table 1. The new data are the largest peak acceleration of the two horizontal components at a site, in most cases scaled by one of the authors (R.L.P.) from the original records. Locations of rupture surface used in distance calculations were taken from ongoing, unpublished studies of the source parameters by several different workers.

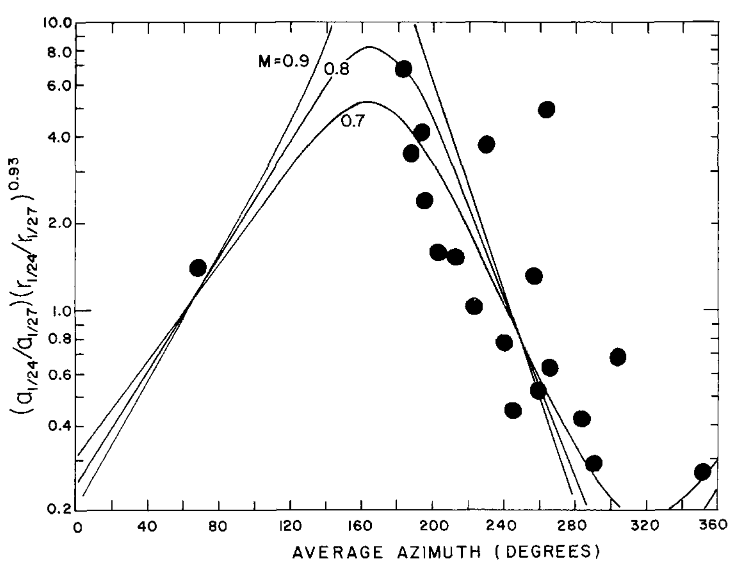

FIG. 2. Ratios of peak acceleration from the 1/27/80 and 1/24/80 Livermore Valley earthquakes recorded at the same sites, plotted against mean azimuth (clockwise from north) from source to station. The data were corrected for distance using a power law with exponent of −0.93 (the value of the slope of the regression line in Figure 1a). Theoretical curves are based on a simple directivity formula [e.g., Boore and Joyner, 1978, equations (2) and (3)] and assume unilateral rupture at azimuths of 170° and 314° for the 1/24 and 1/27 events, respectively. The azimuths are taken from the fault plane solutions of Cockerham *et al.* (1980). Horizontal takeoff of the rays is assumed and the radiation pattern is neglected. M is the ratio of rupture velocity to shear-wave velocity.

Although in general the new data give support to the prediction equations of Boore *et al.* (1980), their real value lies in providing data at close distances; in particular, for the magnitude 6.0 to 6.4 class, the new data confirm our expectation that an extrapolation of the mean regression line to shorter distances is inappropriate. We are currently working on a revision of the regression equations which will include these new data. The report of this research will include tabulations of the data used in this note.

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