SOME STRONG-MOTION RESULTS FROM PAPUA NEW GUINEA 1967-1972

by

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SYNOPSIS

In the period 1967-1972, 16 accelerographs were installed in Papua New Guinea and 44 usable accelerograms have been obtained from 40 earthquakes. The most prolific sites have been at Yonki, on the New Guinea mainland, and at Panguna on Bougainville Island. At Yonki the accelerograph has been triggered by 20 earthquakes, including the magnitude 7, Madang earthquake of October 1970 and its largest aftershock. The main Madang shock took place about 165 km from the accelerograph, which recorded a maximum acceleration of 93 cm/s^2 and a maximum velocity of 4 cm/s. At Panguna, accelerograms have been obtained from five earthquakes including the magnitude 8, Solomon Sea earthquakes of July 1971. These occurred at 210 and 300 km from the accelerograph and produced maximum accelerations of 124 and 59 cm/s^2 and velocities of 13.0 and 5.4 cm/s respectively. The ground response at Yonki and Panguna is shown to be strongly influenced by the local geological conditions, and although empirical relationships between ground movement, magnitude, and distance can be derived, the errors in the regression coefficients preclude accurate predictions of ground motion of these sites.

INTRODUCTION

In the New Guinea region the interaction of the main Pacific and Indian/Australian Plates does not take place along a single boundary. Instead there are several small rigid plates, all moving relatively to the others. Figure 1 indicates the distribution of earthquakes in the region for the period 1958-1970, the probable plate boundaries, and the locations of the accelerographs. The main Pacific Plate is numbered 1, the main Indian/Australian Plate 2, and the others are termed the North Bismarck Sea Plate 3, the South Bismarck Sea Plate 4, the Solomon Sea Plate 5, and the possible Woodlark Basin Plate 6? The strong motion coverage of the region consists of a network of 16 accelerographs made up of 14 MO2s and 2 SMA1s.

RESULTS FROM YONKI AND PANGUNA

At Yonki the accelerograph, situated on about 50 m of recent alluvium, has been triggered by 20 earthquakes. Its companion on hard rock, less than 500 m away, has never been triggered. Figure 2 shows the locations of the Yonki instrument and the earthquakes that triggered it, and figures 4 and 5 show the maximum motions recorded. Least-squares analyses for Yonki lead to the following equations:

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$$\log Ya = 2.26 + (0.40 \pm 0.20)\,ML - (1.41 \pm 0.87)\log R \qquad (1)$$
$$\log Yv = -1.16 + (0.29 \pm 0.16)\,ML - (0.09 \pm 0.12)\log R \qquad (2)$$

here Ya and Yv are in cm/s^2 and cm/s respectively, ML is the Richter magnitude, and R the distance in km. The standard errors of the regression coefficients are large and preclude the use of simple relationships to describe the Yonki results. The spectral analyses of Yonki accelerations exhibit some scatter, but on all the 10 accelerograms analysed, most of the energy is contained in a 2-8 Hz band and 7 of these have the main peak near 4.5 Hz. Figure 6 shows the results from the 1970 Madang earthquake, using 90 s of data. The spectral shape is as typical as any of the spectra obtained: it has a peak near 4.5 Hz and most of the energy lies in the 3-6 Hz frequency band.

The accelerograph at Panguna was installed on unconsolidated volcanic ash and has been triggered by 5 earthquakes. Figure 3 shows the locations of the accelerograph and the earthquakes that triggered it. There are not enough data to attempt a multiple regression, but if the Panguna and Yonki observations are combined the following equations result:

$$\log Ya = 2.91 + (0.32 \pm 0.11)\,Ml - (1.45 \pm 0.57)\log R \qquad (3)$$
$$\log Yv = -0.55 + (0.22 \pm 0.08)\,ML - (0.14 \pm 0.12)\log R \qquad (4)$$

The validity of the combination procedure may be questioned because of the differences in the geological foundation at the two sites but the regression coefficients have much smaller errors when the data are combined.

The power spectra obtained from the Panguna accelerograms have very similar shapes with a peak at 1.8 Hz and do not show the variability observed at Yonki. Figure 7 shows the spectra obtained from the earthquake of 14 July 1971 using 90 s of record in the analysis. One remarkable feature of the earthquake of 14 July 1971 was the duration of the shaking. At the end of 90 s, ground accelerations of about 50 cm/s^2 were still being recorded, making the accelerogram very similar to that obtained in Mexico City in July 1964.

Although good empirical relationships between ground motion, and magnitude and distance, cannot be obtained from the Yonki and Panguna results, the dependence of maximum acceleration and velocity on the observed Modified Mercalli intensity (I) is strong, and least squares gave the following results:

Panguna	Yonki
$\log Ya = (-0.2 \pm 0.3) + (0.4 \pm 0.1)I$	$\log Ya = (0.0 \pm 0.3) + (0.4 \pm 0.1)I$
$\log Yv = (-1.6 \pm 0.2) + (0.4 \pm 0.1)I$	$\log Yv = (-0.6 \pm 0.2) + (0.2 \pm 0.1)I$

These show that the acceleration/intensity relationships are similar at both sites but the velocity/intensity relationships are different.

ACKNOWLEDGEMENTS

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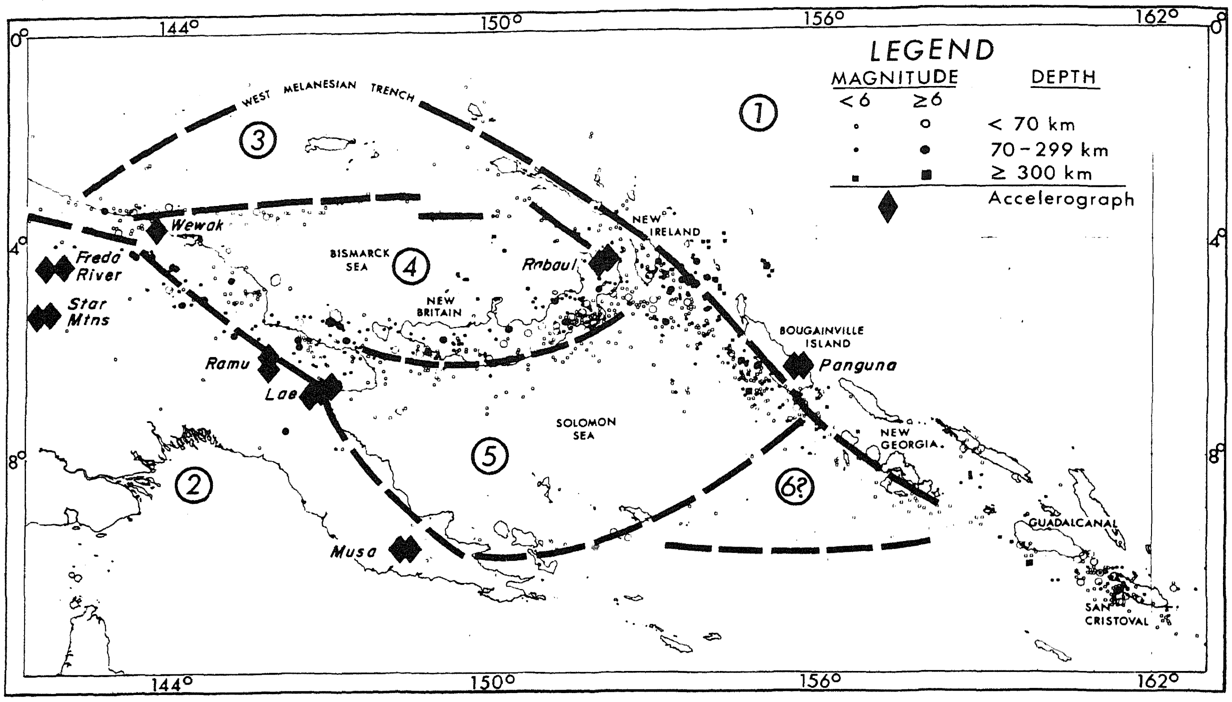

Fig.1 Distribution of earthquakes, plates, and accelerographs – plate nomenclature in text

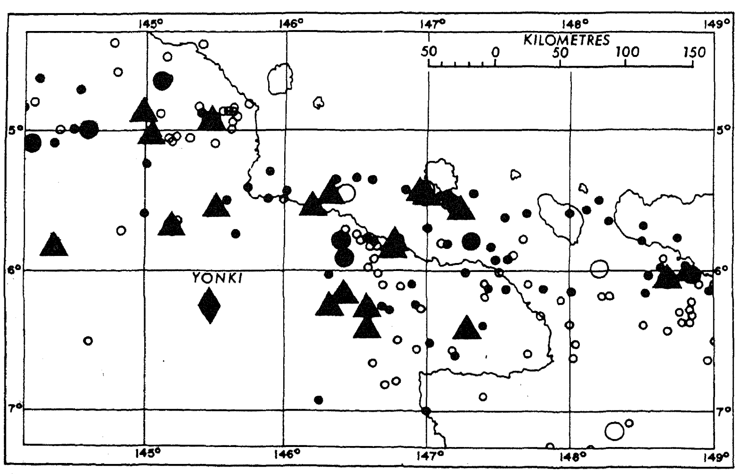

Fig. 2 Earthquakes ▲ which triggered Yonki accelerograph

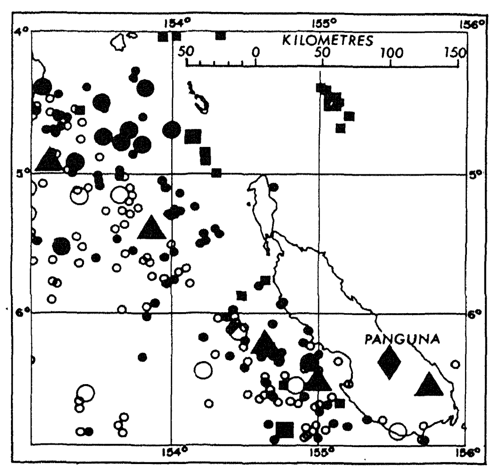

Fig. 3 Earthquakes ▲ which triggered Panguna accelerograph

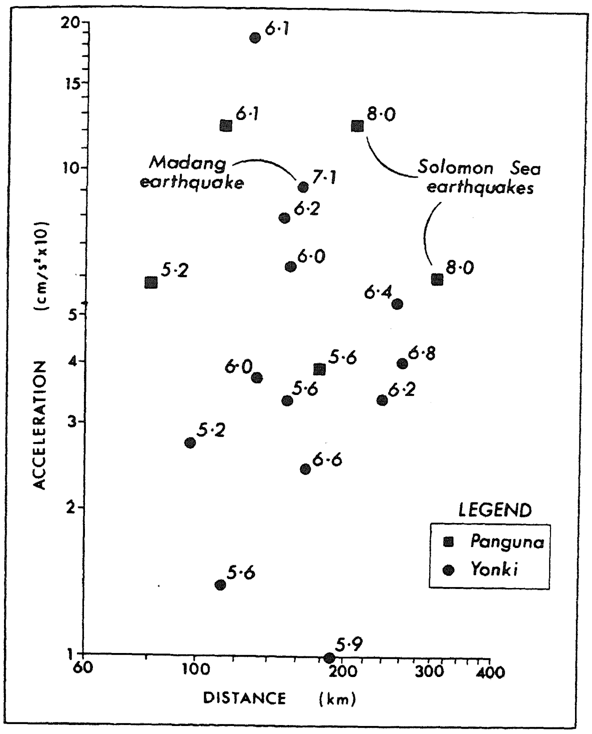

Fig. 4 Maximum accelerations – (6·1, ML magnitude)

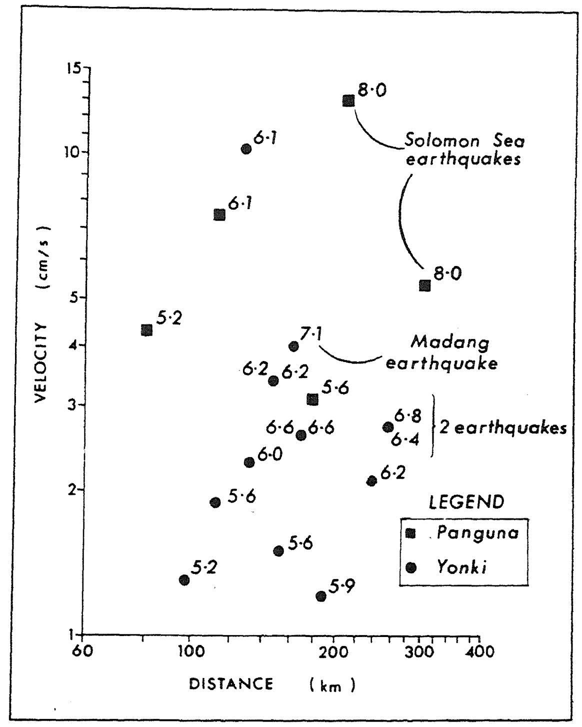

Fig. 5 Maximum velocities – (6·1, ML magnitude)

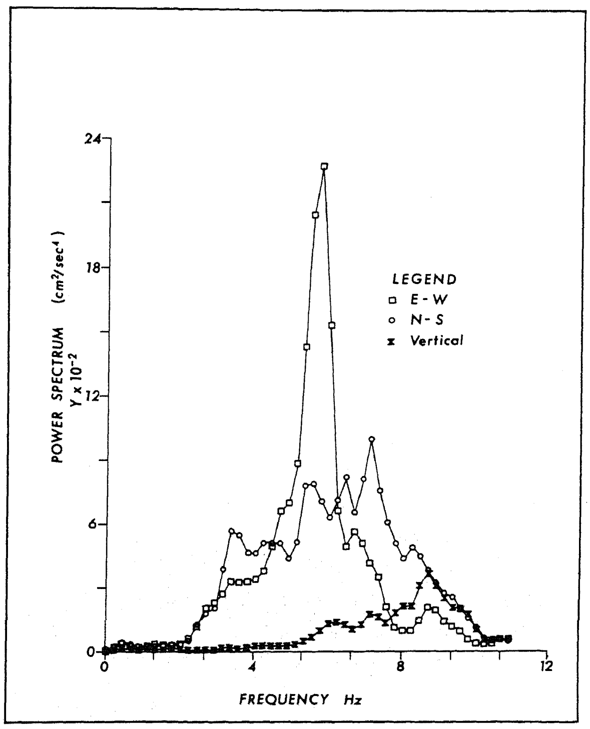

Fig.6 Spectral Analysis – Yonki 31 October 1970

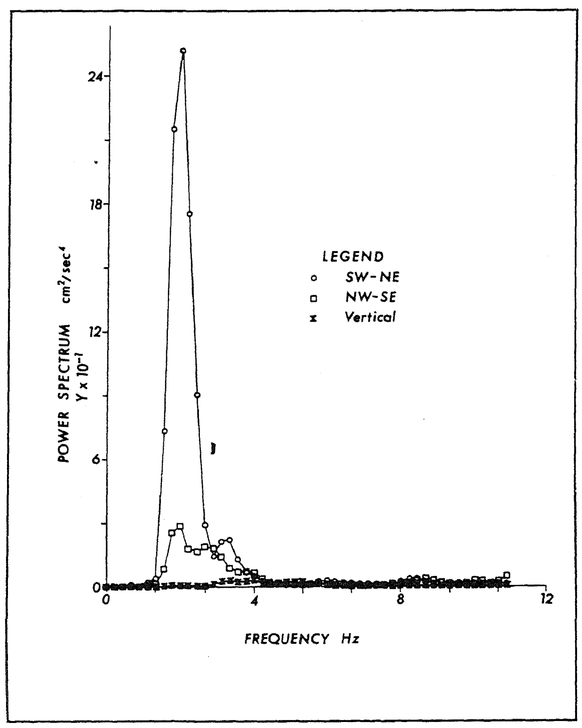

Fig.7 Spectral Analysis – Panguna 14 July 1971