Copy 3

Restricted until after 5th World Conference on Earthquake Engineering

CANCELLED

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/18

THE MAJOR PAPUA NEW GUINEAN EARTHQUAKES NEAR MADANG (1970) AND BENEATH THE NORTH SOLOMON SEA (1971)

by

I.B. Everingham

Record 1973/18

THE MAJOR PAPUA NEW GUINEAN EARTHQUAKES NEAR MADANG (1970) AND BENEATH THE NORTH SOLOMON SEA (1971)

by

I.B. Everingham

THE MAJOR PAPUA NEW GUINEAN EARTHQUAKES NEAR MADANG (1970) AND BENEATH THE NORTH SOLOMON SEA (1971)

by

I.B. Everingham[1]

SYNOPSIS

Intensity, fault-plane, and aftershock results for major Papua New Guinean (PNG) earthquakes which occurred on 31 Oct 1970 and 14 and 26 July 1971 are presented. Some common earthquake shaking effects in PNG are discussed and tabulated in a form suitable for use in estimation of intensities.

THE 1970 MADANG EARTHQUAKE

175309 Oct 31 MS 7.1 4.95°S 145.60°E Depth 40 km

The fault-plane solution and hypocentre pattern suggested a near-vertical, left lateral, strikeslip fault trending ENE near the north coast of New Guinea (Fig. 1). Maximum intensities were at least MM8, and MM7 intensities were experienced over an area of about 25 000 km^2. Extensive landsliding occurred in the epicentral region, and half the village houses were destroyed. Damage in Madang (population 15 000), 30 km from the fault, was mainly to unreinforced masonry structures and corrugated iron water tanks. Bridges, wharfs, and roads in the Madang District were also damaged.

Offshore from Madang, the SEACOM submarine cable was broken in several places owing to submarine slumping of deltaic sediment. A minor tsunami (3 metres maximum) occurred along the shores within 50 km of the earthquake fault. This tsunami was also considered to be caused by submarine slumping, as evidenced by measured changes in sea floor depth and obvious reef damage resulting from the earthquake.

Fourteen of the fifteen deaths were due to landslides that resulted from the 'quake and to collapse of village houses up to 120 km from the epicentre, where the regional intensity was estimated as MM6. One drowning occurred when a boat was swamped by roughened sea.

Cost of damage to buildings was around A$660 000; to roads, wharfs, and bridges A$270 000; and for repairs to the SEACOM cable A$550 000. The cost of replacing 847 village houses destroyed by the earthquake was about A$100 000 allowing for salvaged materials. The total damage cost A$1.7 million.

THE 1971 NORTH SOLOMON SEA EARTHQUAKES

061129	Jul 14	MS 8.0	5.47°S	153.88°E	Depth 47 km
012321	Jul 26	MS 8.0	4.94°S	153.17°E	Depth 48 km

The epicentres were located in the northernmost part of the Solomon Sea in the most active zone of seismicity in PNG. Twenty-three

[1]Observer-in-Charge, Bureau of Mineral Resources Geophysical Observatory, Port Moresby, Papua New Guinea.

shocks with MS greater than 6.9 have occurred in the area since 1900. Aftershock and fault-plane solutions suggest that the earthquake resulted from faulting of two parts of a single fault zone that extends from west of Bougainville Island along the trend of the trench to Pomio on the south coast of New Britain (Fig. 1).

Maximum intensities were at least MM8, and the MM8 isoseismal approximately enclosed the zone of aftershock epicentres for each earthquake; i.e. the shaking appeared to be directly related to distance from the faulted zone, not the epicentre (Fig. 2). Hence although Rabaul was twice as far from the first epicentre as from the second, the intensities at Rabaul during the two earthquakes were about the same. The longer axes of the elliptical MM7 isoseismals were roughly 500 km long, and for each 'quake the area with MM7 intensities is estimated to be roughly 400 000 km^2.

Both earthquakes caused two- to three-metre tsunamis which were experienced in Rabaul, southeastern New Britain, western Bougainville and southern New Ireland. In three small areas the tsunami waves from the 26 July event were anomalous, being as high as eight metres. Many small wharfs, whether well constructed or not, were damaged or washed away, and in Rabaul the contents of low-lying stores, factories, a hotel, and residences were ruined by flooding. It was not possible to make an accurate assessment of damage as the area damaged was vast, sparsely populated, and communications were difficult. In the vicinity of Rabaul (population 25 000), the only town of note, several timber framed houses were thrown off concrete-pile foundations, piles were cracked, and unreinforced masonry buildings were ruined. Here damage amounted to roughly A$270 000; total cost of the damage was probably about twice this amount. Only one life was known to have been lost - that of a child drowned by the 14 July tsunami.

REMARKS

Typical earthquake effects are summarized in the Table, which was designed to facilitate uniform intensity estimation in Papua New Guinea, a tropical, mountainous, relatively undeveloped country.

One feature of PNG earthquakes is the relatively high intensities that occur on hilltops. After the July 1971 shocks this was particularly noticeable in the Rabaul area, where field evidence was most easily acquired. An MO2 accelerograph placed on a hilltop site at Rabaul triggered 8 times during the period Sept 1971-Sept 1972, whereas an MO2 in a lower site in the township failed to trigger during that time. Figure 3, showing parts of accelerograms from a valley hardrock site and from an adjacent hilltop about 300 metres higher (at a dam site in eastern Papua), illustrates the large difference in the ground motions at the two sites and suggests that the MM intensity on the hilltop would have been considerably higher than at the valley site.

It is noteworthy that in this rapidly developing country: (a) the major damage has been to structures erected during the 15 years before the introduction in 1971 of earthquake loading provisions in the building regulations; and (b) earthquake damage costs have risen with the country's development.

TABLE FOR EVALUATION OF INTENSITY

EFFECT	MM5	MM6	MM7	MM8
GROUND MOVEMENTS	Strong. Felt by all	Very strong. Slightly affects walking	Difficult to stand	People thrown down
SEEN/HEARD (other sounds) (apart from) (rumbling)	Unstable objects move. Pictures swing. Tree movements obvious. Water sloshes in tanks.	Objects fall, furniture moves. Trees strongly shaken. Water sloshes out from tanks.	Ground waves. Water waves.	Odd trees fall.
AWAKENED	All except a few heavy sleepers	All	All	All
ALARMED	Few alarmed	Many alarmed. Run out of doors.	All alarmed	Some terrified.
DAMAGE	Weaker water tanks leak	Few water tanks burst. Obvious cracks in weak masonry. A few weak village huts collapse	Many tanks burst. Unreinforced brick walls collapse. Weaker village huts collapse. Minor damage to house stumps.	Timber framed huts and houses off stumps. Roughly half village huts off stumps or thrown down.
SLUMPING AND LANDSLIDES	Occasional landslides	Occasional landslides.	A few landslides. Settlement and cracking of unconsolidated ground.	Extensive landslides. Bad slumping of built-up areas. Reef settlement.

ACKNOWLEDGEMENTS

I thank the Director of the Bureau of Mineral Resources for permission to publish these results.

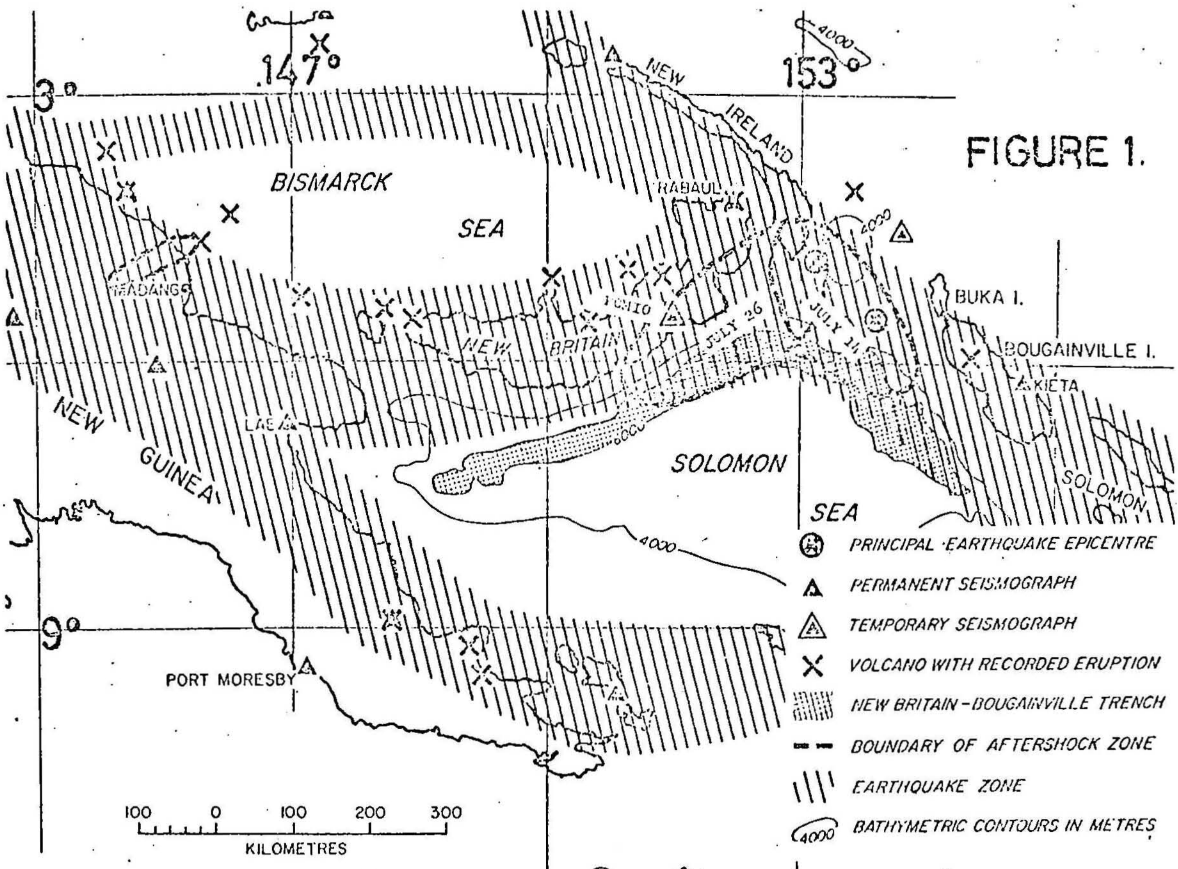

FIGURE 1.

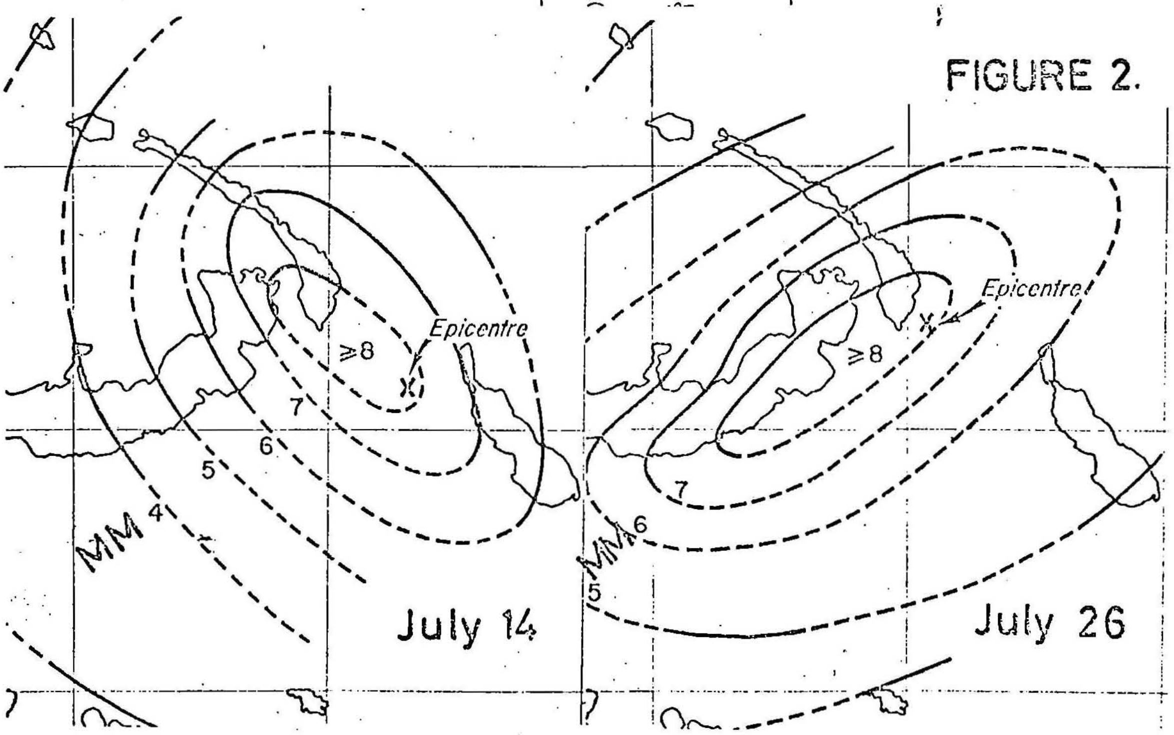

FIGURE 2.

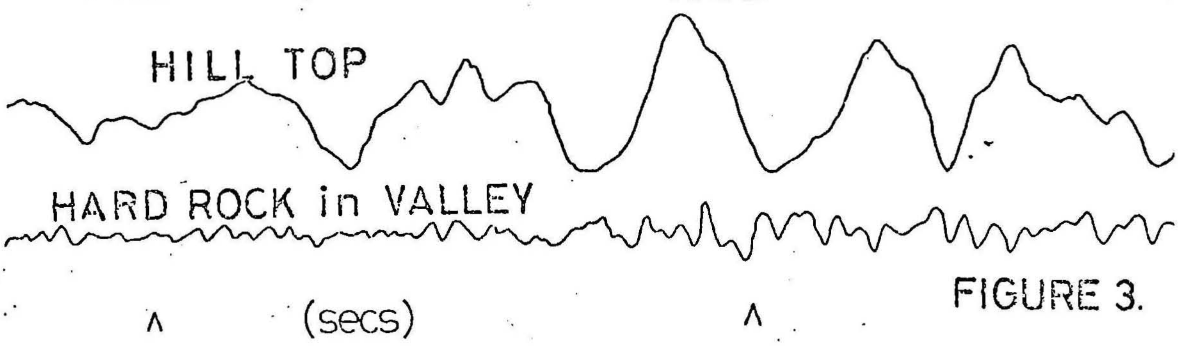

FIGURE 3.