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DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1973/20

A SUBMARINE SLUMP AND TSUNAMI IN THE LAE AREA OF PAPUA NEW GUINEA, 26 AUGUST 1972

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SUMMARY

In one locality at Lae, Papua New Guinea, on 26 August 1972, the sea level fluctuated over a range of about 2.4 metres during a period of several minutes. Tide-guage and seismograph records suggest that a submarine slump close to the shore at Lae caused the abnormal sea waves, which could be termed a tsunami.

The slump was not triggered by an earthquake. This evidence and evidence of other slumps indicates that during some periods sediment accumulates offshore from Lae more quickly than earthquakes can remove it, despite the high seismicity of the area.

Because of seasonal influences on sedimentation there is a strong tendency for offshore slumping at Lae to occur more frequently during the months of August and September.

1. OBSERVED EFFECTS

During daylight, at about 0815 UT (1815 local time) on 26 August 1972, unusual sea waves were noted at the Lae small-boat harbour at Voco Point (see Figs 1 and 2) by Mr V. Dawson and others. Mr Dawson (pers. comm.) stated that the sea surged into the fairly open bay which forms the boat harbour, receded, and surged in again to a greater extent, sinking one boat and beaching another. Mr Dawson estimated that the time interval between the two surges was about two minutes and that the sea rose 5 ft (1.5 m) and fell 3 ft (0.9 m) respectively above and below its normal level at Voco Point. He stated that minor surging occurred during the half-hour following the initial waves.

Three kilometres from Voco Point at the main Lae wharf a Bristol tide gauge registered a sharp decrease in sea level at 0810$\pm$3 (see Fig. 3). The decrease in sea level lasted for about 10 minutes; the maximum amplitude registered on the gauge was only 4 cm. It is possible that the decrease was preceded by a minor upward surge of very short period, but that details of this wave and other rapid fluctuations in the sea level were unrecorded because the instrument is not designed to efficiently record waves with periods of the order of a minute.

Between about 0811.5 and 0826 the Bureau of Mineral Resources' seismograph, sited about 8 km inland near the Lae Institute of Technology, recorded ground vibrations (see Fig. 4) which were not from an earthquake but were considered to be due to a submarine landslide (submarine, because of the lengthy period over which sliding occurred). This landslide would have certainly been the cause of the anomalous sea waves, which were of the same type as the tsunamis commonly noted as a result of submarine slides caused by earthquakes.

2. DISCUSSION

26 August 1972 event

The near coincidence of the arrival times of the first sea wave and the initial vibrations recorded by the seismograph, suggest that the slide must have been very close to Lae. This is supported by the lack of reports of waves from coastal areas around the Huon Gulf. Indeed, the slide could well have been very close to Voco Point, because the sea waves were most noticeable there. Further, the instability of the sediment near this part of the coastline has been noted in the past; e.g. in that area during August 1932, a slide removed about five acres of land along the foreshore, together with a jetty, a crane, and 100 metres of railway line. A newspaper report of that event is given in Appendix 1, and remarks by Hattersley, Foster & Stone (1967) and Krause, White, Piper & Heezen (1970) pertaining to the stability of sediments along the Lae coastline are given in Appendixes 2 and 3. A minor sea floor valley extending seawards from Voco Point (Fig. 2) is also an indication of sediment sliding from that area.

Large marine slumps are frequently converted to turbidity currents (bodies of water carrying suspended sediments) which can travel hundreds of kilometres along channels in the sea floor (Menard, 1964, p. 196). The currents can sometimes be detected when they damage submarine cables in their path. Evidently the slump under discussion did not cause a strong turbidity current, because the submarine telephone communication (SEACOM) cables crossing the New Britain Trench about 200 km east of Lae were unaffected.

Krause et al. (1970) pointed out that the rivers bring down large amounts of sediment into the western part of the deep ocean trench (the Markham Canyon - see Von der Borch, 1969) that extends from near the mouth of the Markham River along the centre of the Huon Gulf into the New Britain Trench (Fig. 1). They considered that slippages of the sediment that has temporarily accumulated at the river mouths (the Markham being the largest) were the probable sources of turbidity currents such as those that cut the SEACOM cables in the New Britain Trench after earthquakes in 1966 and 1968. Submarine slumping from the Gogol River delta, triggered by the earthquake centred 50 km northwest of Madang on 31 October 1970, also snapped SEACOM cables (Everingham, in prep.).

The velocity of turbidity currents is of interest because it is high compared with other water currents. Krause et al (1970), assuming that the most likely source of the turbidity currents that damage SEACOM cables in 1966 and 1968 was the Markham River delta, found average velocities of 50 and 30 km/h for the currents. These were maximum values, because the source could have been closer than assumed.

One of at least two processes could have generated the ground vibrations recorded on the Lae seismograph: in the first, a more or less continuous series of small slumps could have occurred in the one locality; in the second, a large concentrated mass of sediment could have moved down the 30° slope immediately offshore from the slump source. If it was assumed that (a) the second process took place, (b) the slump originated close to that part of the coast which trends E-W in the Voco Point area (about 8 km from the seismograph station), and (c) the amplitude of seismic waves is inversely proportional to the square of distance from the source, a velocity of 40 km/h is derived from the amplitudes of the recorded seismic waves. The velocity is thus of the same order as turbidity current velocities; if the assumptions are correct, this velocity suggests that the slump was transformed into a turbidity current very near its source. However, the mechanism of slumping is speculative, and the seismic records prove only that slumping of some sort was active for at least 18 min.

Other events 1969-1972

The tide gauge at Lae wharf commenced reliable operation on 27 July 1971. Examination of the records for the period 27 January 1971 to 27 September 1972 showed other events similar to that on the 26 August 1972 (see Fig. 3). The tide gauge recordings indicated small but rapid changes in sea level quite distinct from long-period cyclical effects typical of tsunamis from distant sources. The details of time, amplitude, associated earthquakes, and state of the sea are listed in Table 1.

All but one event occurred during the months of August or September. Apart from the event of 26 August 1972, three suspected slumps (including that in 1932) have occurred without a known triggering agent.

The fact that submarine slides not triggered by earthquakes have occurred off Lae is clear evidence of the instability of the near-shore sediments, and large shallow earthquakes near Lae would almost certainly cause marine slides, associated turbidity currents, and tsunamis. Krause et al. (1970) suggested that in the Huon Gulf enough earthquakes occur to trigger any mass of sediment whenever it approaches instability. However, the fact that four documented events not triggered by earthquakes, occurred during the month of August (1932, 1971, and 1972), suggests that seasonal variations of rainfall or ocean conditions must at times contribute largely to the slump frequency; i.e. during some seasons sediment can accumulate faster than earthquakes can remove it. In an area of such high earthquake activity as the Lae area, this can occur only if sedimentation is extremely rapid.

3. CONCLUSIONS

(a) A submarine slump started close to Voco Point, Lae, at about 0811 hours UT on 26 August 1972.

(b) The slump caused sea waves (a tsunami) with a maximum peak-to-trough range of 2.4 metres.

(c) The slump was not triggered by an earthquake.

(d) The slump was active for at least 18 minutes.

(e) There is no evidence of conversion of the slump to a turbidity current at any great distance from the source, although there is weak evidence that a turbidity current was generated close to the source.

(f) Sediment is deposited very quickly immediately offshore from Lae and owing to seasonal conditions the slump frequency is possibly greatest during August.

(g) Tide gauges could be used for detecting (and possibly for locating) submarine slumps in the Huon Gulf.

4. ACKNOWLEDGMENTS

The assistance of Mr V. Dawson in describing the waves at Voco Point, and of the PNG Harbours Board for permitting use of their tide gauge record, is gratefully acknowledged.

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APPENDIX 1

Extract from the 'Pacific Islands Monthly' - 21 September 1932

'There is no possibility of establishing a deep water wharf for steamers at Lae. As a matter of fact, the possibilities of putting even a small wharf on this shore for the use of light craft is now seriously questioned. There is a crumbling, friable shore at Lae, which is being steadily eaten away by the waters from the Markham River, which run into the sea just westward of the aerodrome. One of several outlets of the Markham appears to rush along the foreshore in front of the aerodrome, and the erosion is constant. Men who have known the spot for a long time declare that a depth of at least 400 yards of shore has been swept away in the last five years. At the end of August, about five acres of the shore, eastwards of the aerodrome, simply slid into the sea, carrying with it the wharf that had been build for light craft, two or three sheds at the end of the wharf, the large steam crane, and about 100 yards of railway. Captains of steamers which regularly anchor off this shore declare that there is a shelf, extending out a couple of hundred yards, where the depth is not great, but where the bottom is very soft and shifty, and then beyond that the bottom drops sharply down into enormous depth. There is a sharp current which sweeps along the shore eastwards from the Markham River, and there is a more or less heavy swell, which is almost constant here during the south-east season. Guinea Airways, Limited, and the associated Gold Companies are building another wharf and providing another steam crane, but the recent accident shows what they have to contend against, and bears out in a somewhat remarkable manner the arguments of the shipping interests against the establishment of a permanent port at Lae.'

APPENDIX 2

Extract from report by Hattersley, Foster & Stone (1967)

'Conclusions

The beach between Voco Point and the airstrip is eroding in such a manner as to align itself normal to the wave attack, but it is not clear from the evidence available why stability of the beach at this locality has not been achieved long ago. Possibly because of the sheltered locality, erosion is a feature of the more severe trade wind seasons and is therefore intermittent.

The foregoing study indicates that sand causing the shoaling at Voco Point originates in the Busu or Butibum Rivers and is moved westward along the coast by wave action. The shoal is formed when the wave energy decreases as the waves round the point.'

APPENDIX 3

Extract from paper by Krause, White, Piper & Heezen (1970)

'Evidence of Sediment Instability and Slumping

Foreshore instability at the mouth of the Markham River is seen in past events, such as the disappearance of part of the beach and a landing jetty at Voco Bay (in front of Lae) and as erosion and slumping between Voco Bay and the end of the Lae airstrip.

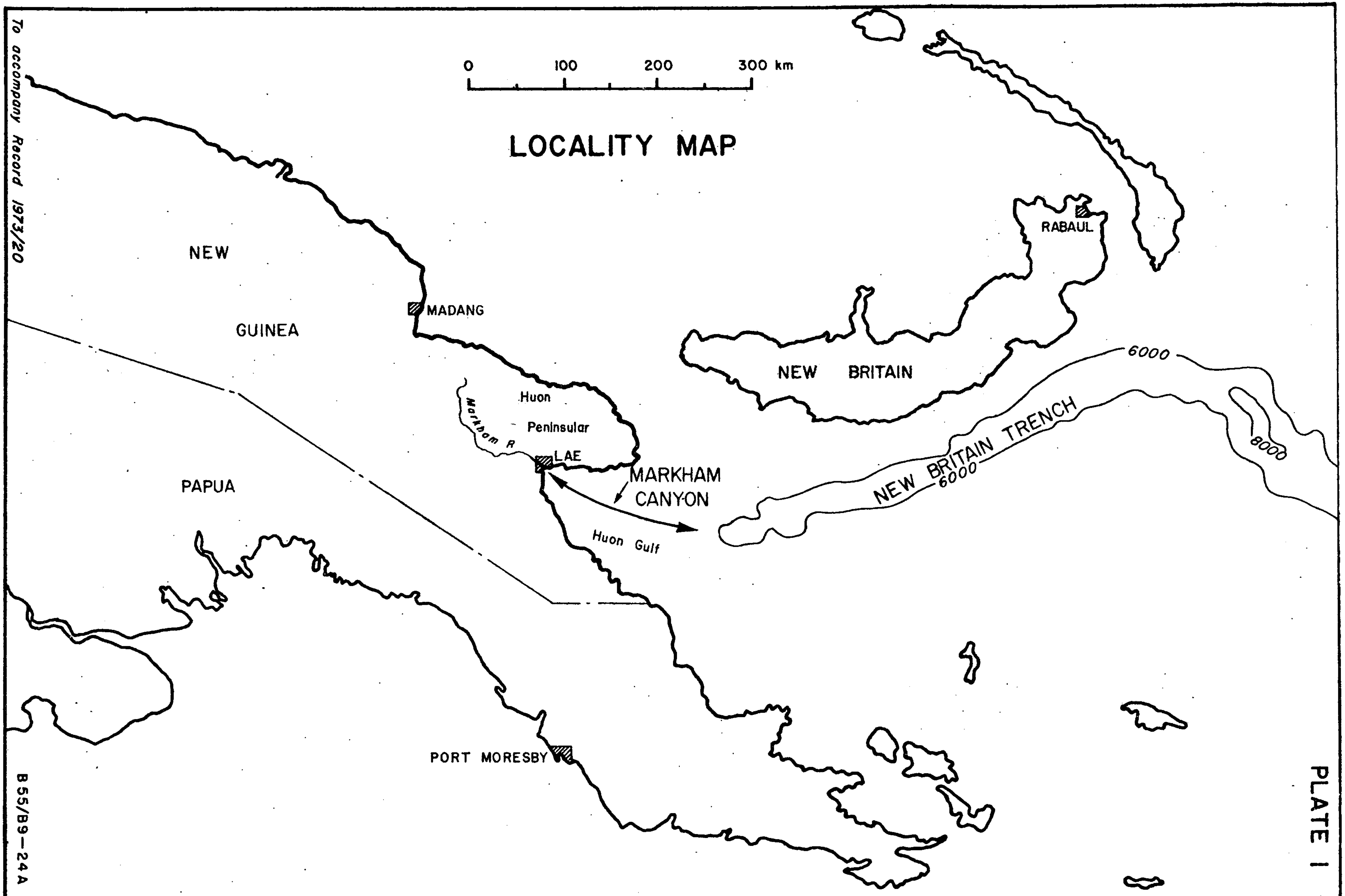
The beach at Lae was slowly aggrading in July 1961. Beneath the few inches of sand and gravel then being deposited on the beach is a very soft, wet clay similar to that in the extensive swamp which backs the beach. Any beach deposited rapidly on such a weak, well-lubricated foundation is liable to slump seaward, whether from the weight of the sand deposited, the effect of earth tremors, or the scouring action of the local, variable, strong currents.

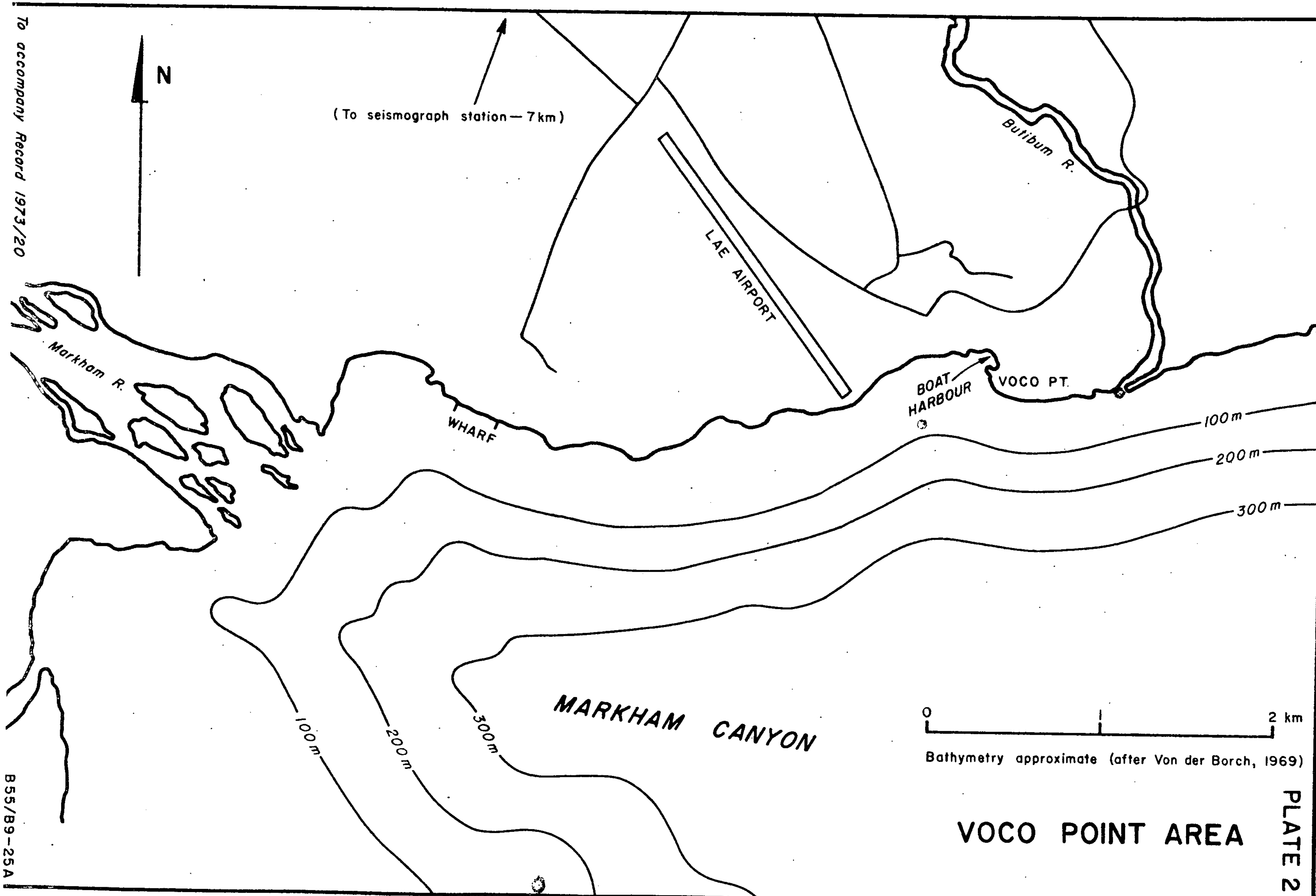
Furthermore, rapid depositional changes occur along the shore due to the highly variable currents, which are in turn influenced by the constantly shifting sand bars at the Markham River mouth. Such changes at Lae in July, 1961, consisted of the rapid deposition of very fluid silt at the wharf, the position changes of the nearby small Butibum River mouth and the rapid growth of the Voco Point sand-spit.'

PROBABLE SLUMPS IN THE LAE AREA, AUGUST 1969 TO SEPTEMBER 1972

Date	Time (UT)	Tide Gauge Max. Amplitude (metres)	Sea Waves Duration (minutes)	Possible Trigger	Remarks
1969					
02 Aug	0431	Not in operation		'Quake	Earthquake at 04 30 29 UT, 6.55°S 146.92°E, depth 17 km, MB (ERL) 5.3 Intensity MM4. Huon Gulf. Sea level fluctuation observed at Lae. Probable slump.
1971					
12 Feb	1910	-0.10	16	'Quake	Calm seas. Earthquake at 19 06 54 UT, 6.25°S 146.48°E, depth 113 km MB (ERL) 5.7 Intensities MM 4-6 Huon Gulf area. Slump close to Lae, seismic effect (if any), masked by 'quake
23 Aug	1256	+0.02	9	Nil	Calm seas. No earthquake No effect recorded on seismograph Slump in Huon Gulf
25 Sep	0438	-0.24	25 pulse 132 disturbed sea	'Quake	Moderate seas. Earthquake at 04 36 14 UT, 6.54°S 146.48°E, depth 115 km, MB(ERL) 6.3 Intensities MM 4-6 Huon Gulf area. 2.0 m rise in sea level a few minutes after 'quake at Salamaua Slumps close to Lae, Salamaua; seismic effect (if any) masked by 'quake

Date	Time (UT)	Tide Gauge Max. Amplitude (metres)	Sea Waves Duration (minutes)	Possible Trigger	Remarks
30 Sep	2200	+0.05 -0.10	10 1st pulse 47 total	Sea action? Possibly not a slump	Rough seas. No earthquake Lae seismograph inoperative. Shape of tide gauge anomaly and sudden change in sea roughness suggest that sea level changes could be due to either slumping or the weather.
1972					
24 Aug	2210	-0.19	6	Sea action?	Moderate to rough seas. No effect recorded on seismograph. No earthquake. Slump in Huon Gulf
26 Aug	0810	-0.19	12	Sea action?	Moderate to rough seas. Effects recorded on seismograph. No earthquake. 2.0 m rise in sea level observed at Voco Point, Lae. Slump close to Lae.


To accompany Record 1973/20
0
100
200
300 km
LOCALITY MAP
RABAUL
NEW
GUINEA
MADANG
NEW BRITAIN
6000
Huon
Markham R
Peninsular
LAE
MARKHAM
CANYON
NEW BRITAIN TRENCH
6000
8000
PAPUA
Huon Gulf
PORT MORESBY
B55/B9-24A
PLATE 1

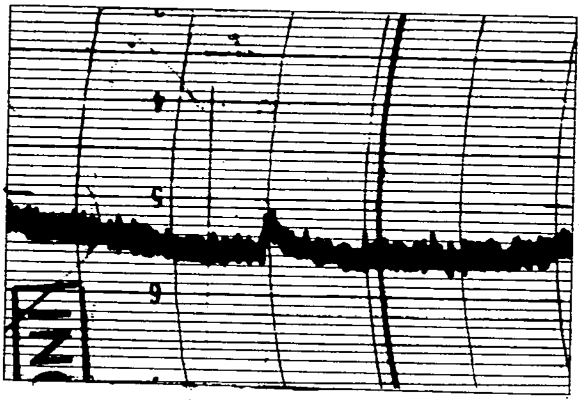


VOCO POINT AREA

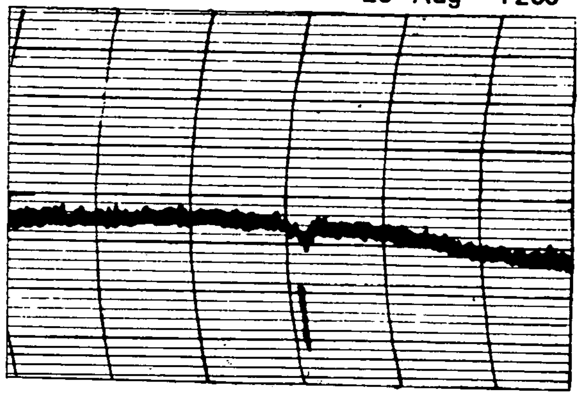
PLATE 2

PLATE 3

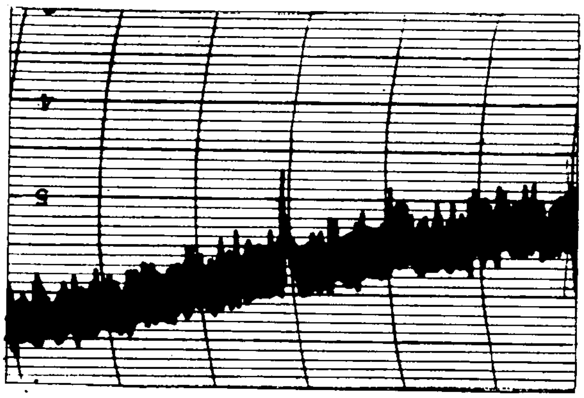
1971
12 Feb 1910



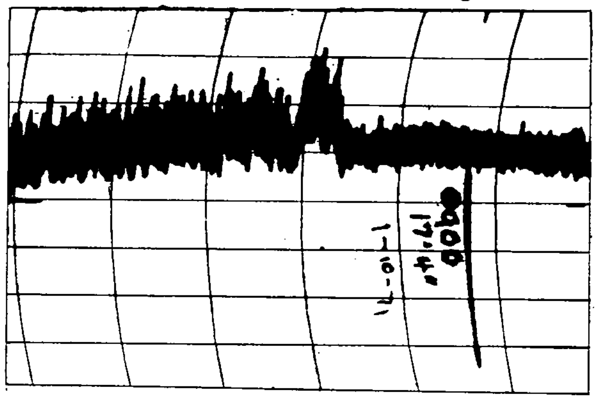
1971
23 Aug 1256



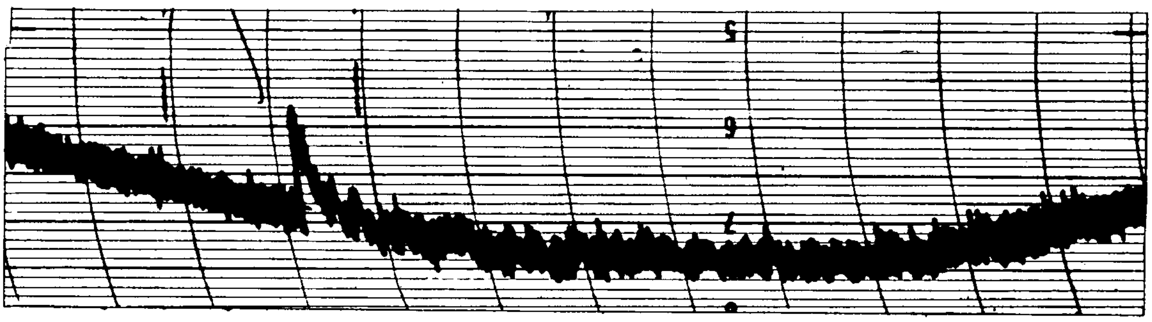
1971
30 Sep 2200



1972
24 Aug 2210



1971
25 Sep 0438



1972
26 Aug 0810

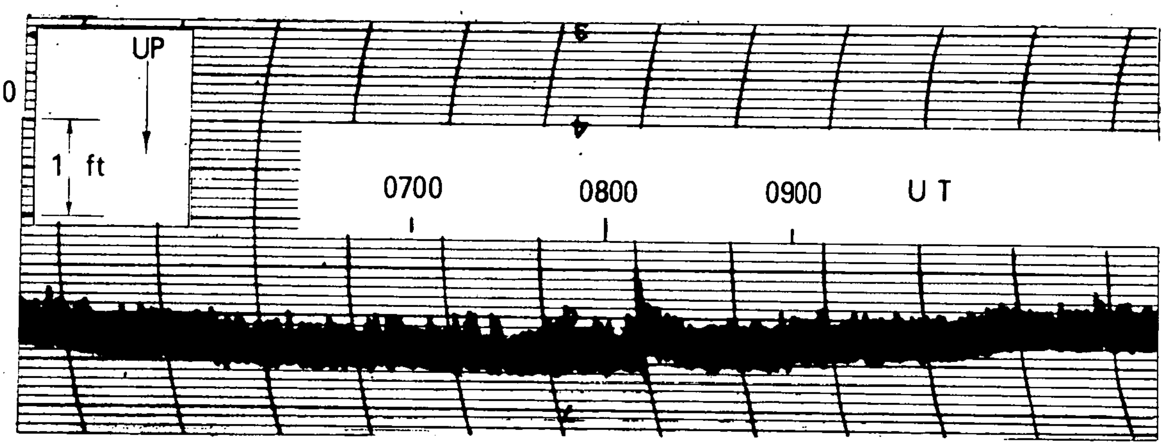
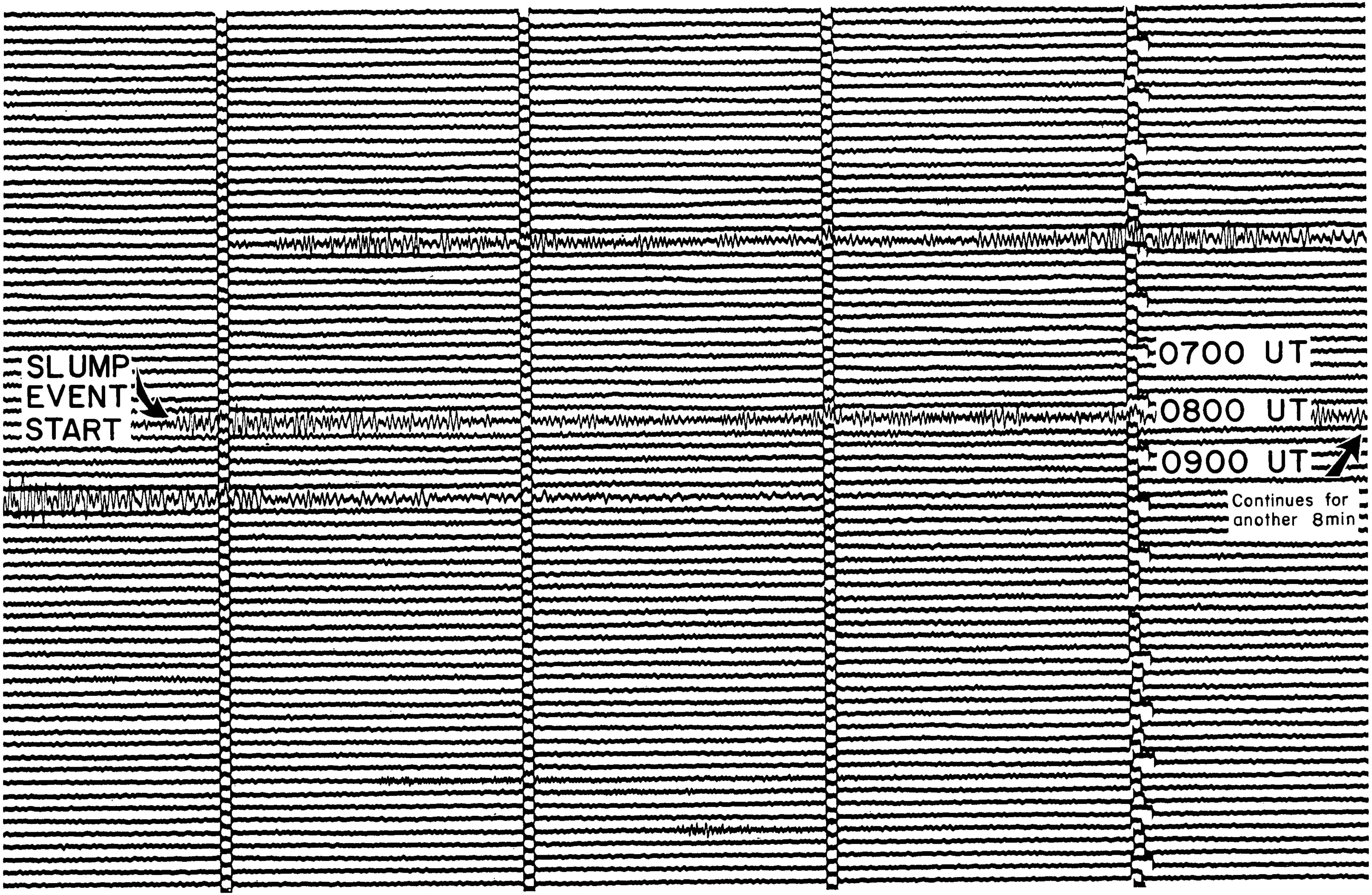


FIGURE 3

TIDE GAUGE RECORDS

To accompany Record 1973/20



SEISMOGRAM

PLATE 4

B55/B9-27A