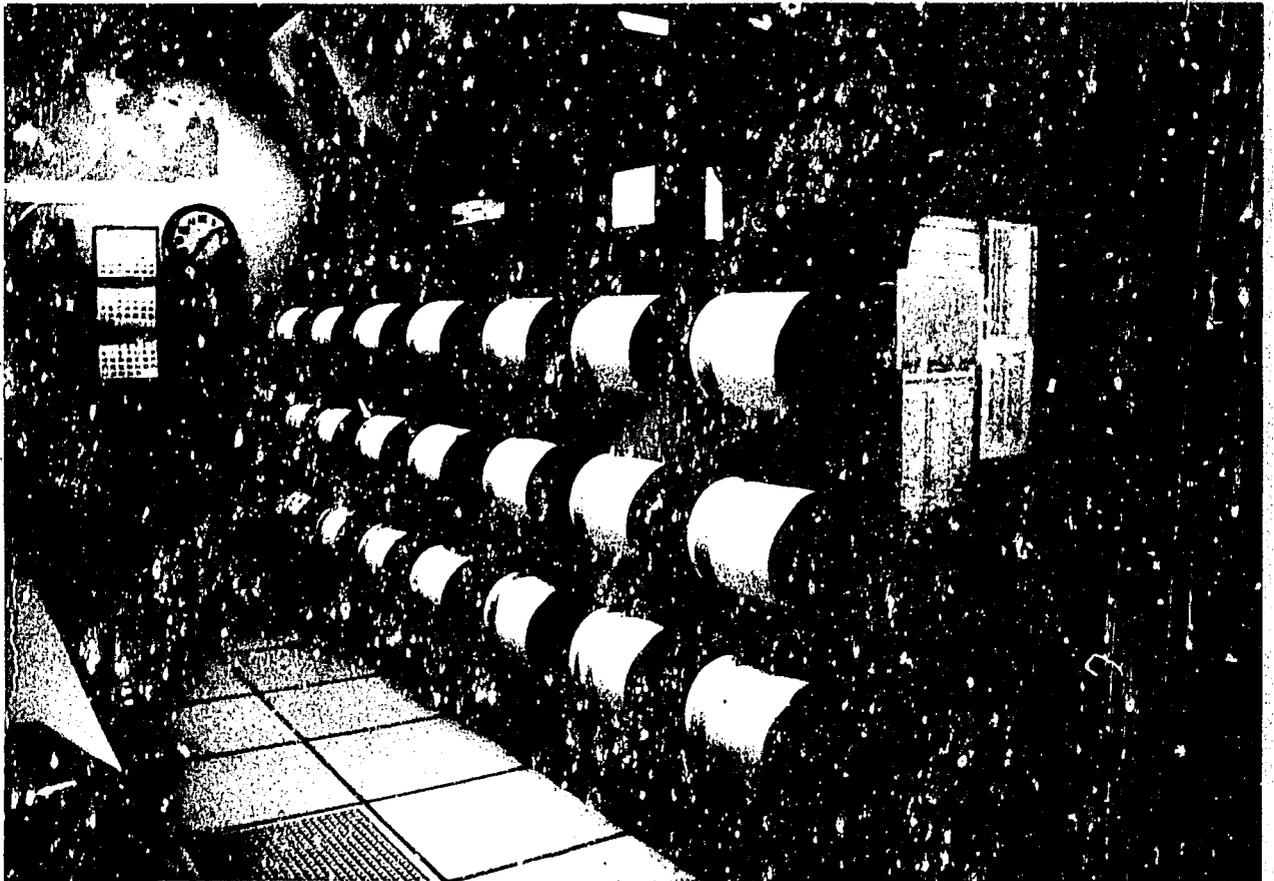


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SOUTHEAST ASIA ASSOCIATION OF SEISMOLOGY
AND EARTHQUAKE ENGINEERING

Series on Seismology
VOLUME III



MALAYSIA



**SOUTHEAST ASIA ASSOCIATION OF SEISMOLOGY
AND EARTHQUAKE ENGINEERING**

**Mr Ho Tong-Yuen, President
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Series on Seismology

Volume III - MALAYSIA

**PART A MACROSEISMIC STUDY OF MALAYSIA
PART B EARTHQUAKE INTENSITY ANALYSIS
PART C SEISMOTECTONIC SETTING OF MALAYSIA**

by

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June 1985

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PART A
MACROSEISMIC STUDY OF MALAYSIA

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PART A MACROSEISMIC STUDY OF MALAYSIA

Introduction

The Macroseismic Study of Malaysia is one of the studies carried out under the Earthquake Disaster Mitigation Project and coordinated by the Southeast Asia Association of Seismology and Earthquake Engineering (SEASEE). Its aim is to collect all available information on earthquakes that have occurred or affected Malaysia and its adjacent areas in the past. The study was headed by Mr Leyu Chong Hua, as principal investigator. He was assisted by a team of eight key members and several other persons who helped to collect the necessary information from various sources inside and outside the country.

Collection of past earthquake information is indeed a formidable task. Information is scattered everywhere - in newspapers, government gazettes, geological reports or journals, official or private correspondence, historical books, etc. In order to locate the required information, there is no other alternative but to scan through carefully these voluminous amounts of documents.

As a first step of the study, the team explored the various possible sources, locally and overseas, where the required information is available. Enquiries were made, directly or indirectly, at the British and Dutch museums, libraries, archives and various other sources overseas. Enquiries were also made at various local sources. Consequently, the following sources where the required information is available were identified:

- a) the University Library, University of Malaya, Kuala Lumpur
- b) the National Archives, Kuala Lumpur
- c) the National Library, Kuala Lumpur
- d) the Sabah State Library
- e) the Sabah State Archives
- f) the Sarawak Museum
- g) the Singapore National Library

Having identified the sources, the team of investigators came down to serious research. They painstakingly searched through all the available newspapers and government gazettes - most of these are stored on microfilm. It was found that they constituted the best sources of information and provided a complete chronological documentation and description of events. Having exhausted these sources, the team then turned its attention to the secondary sources such as reports, journals, correspondence, historical books, etc. for additional information.

Besides the above efforts, several local people active in the field of seismology were approached to search their collection of relevant earthquake information.

As a result of the effort of the team, it can be confidently said that this report provides a more or less complete coverage of earthquake information of Malaysia for the periods mentioned below:-

- a) Peninsular Malaysia, 1805 to May 1984
- b) Sarawak, 1870 to May 1984
- c) Sabah, 1884 to May 1984

For Peninsular Malaysia, the Straits Times (later renamed the New Straits Times) which was established in the year 1831, provided the longest and most complete coverage. This information was augmented by other newspapers such as the Prince of Wales Island Gazette (1806 to 1827), Singapore Chronicle (1827 to 1835), Singapore Free Press, Penang Shimbun (1943 to 1945) and several other newspapers.

For Sarawak the coverage was provided by the Sarawak Gazette, whilst for Sabah it was provided by the British North Borneo Herald (1884 to 1960) and augmented by the North Borneo News and Sabah Times (1961 to 1963), Sabah Times (from 1963) and several other newspapers.

The list of newspaper completely or partially scanned is presented after the "ACKNOWLEDGEMENTS".

In this report, all the events are checked with the earthquake list provided by the National Earthquake Information Service (NEIS), United States Geological Survey. If the earthquake is identified, the origin time together with epicentral and magnitude values as given by NEIS are used. If the earthquake is not identified, it is then checked with the earthquake list supplied by SEASEE Secretariat, Manila. However, if it is still not identified, the approximate local time at which the earthquake shock was reported felt is then given. The various local times used in Malaysia are explained in Appendix I.

Acknowledgements

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assistance, in one form or another, to this study.

List of Newspapers and Gazettes Scanned

Malacca Residents Diary	- Aug 1826 to Dec 1828
Penang Guardian and Mercantile Advertiser	- 15 Aug 1873 to 16 Mar 1884
Penang Shimbun	- 8 Dec 1942 to 1 Sep 1945
Singapore Chronicle	- 4 Jan 1827 to 28 Nov 1835
Singapore Free Press	-
Prince of Wales Island Gazette	- 22 Mar 1806 to 30 Dec 1815
Penang Register & Miscellany	- 22 Aug 1827 to 17 Sep 1828
The Straits Times/New Straits	- 1831--
The Malay Mail	- 1896--
British North Borneo Herald	- 1884 to 1960
North Borneo News and Sabah Times	- 1961 to Aug 1963
Sabah Times	- Sept 1963--
Daily Express	- 1963--
Sarawak Gazette	- 1870--
Sin Chew Jit Poh	-
Penang Argus & Mercantile Advertiser	- 1867 to 1873
Yit Khoon Poh	-

PENNINSULAR MALAYSIA

Event	Felt Effect	Intensity MM	Source
1815 Dec 6 06 hr 30 m L.T.	Penang: A slight shock of an earthquake occurred at about 6.30 a.m. It was perceived by a gentleman at his residence in Georgetown while sitting in the upper part of the house. The sensation of motion was so great as to induce him to rise from his chair, when the undulation of his person became still more perceptible and the heavy fabric suspended from the wall was seen to vibrate like the pendulum of a clock and continued in this state for some minutes. The above sensation was distinctly felt by several persons living in the Penang Road near the burial ground and the agitation of the neighbourhood was stated to have been very remarkable.	II	P.W.I.G. Dec 9, 1815
(i) 1833 Nov 24 20 hr 35 m L.T.	Singapore: At 25 minutes to 9 o'clock at night (Sunday) a slight shock of an earthquake lasting for more than a minute was distinctly felt in Singapore, (and two slighter shocks were perceptible in the early morning, one at 3, and the other at 4.30 a.m.). The punkahs were set moving by the motion. (It was the first phenomenon of the kind that had occurred since the formation of the Settlement i.e. 1819).		
(ii) 1833 Nov 25 03 hr 00 m L.T.			
(iii) 1833 Nov 25 04 hr 30 m L.T.			
		II-III	A.H.S. & S.C. Nov 28, 1833

Event	Felt Effect	Intensity MM	Source
	Penang: A few minutes after 8 o'clock, a smart shock of earthquake was felt both in town and country. The undulations lasted for about half a minute and seemed to proceed from east to west.	II	S.C. Dec 19, 1833
	Malacca: Similar shocks were felt here.	II	-- do --
	Remark: It was conjectured that the volcano Gunong Merapi, in Sumatra, was in violent eruption.		
1837	Singapore: An earth tremor was felt in Singapore. A large wave broke on the sea-shore at Teluk Ayer.		A.H.S.
	Penang: It occurred at mid-day. It was described as a severe tremor and caused considerable alarm. The European inhabitants rushed out of their counting house to evade the impending danger. It was said that the earth absolutely shook in disarray at the Commissioner's outpost.	III-IV	S.T. Mar, 1861.
1843 Jan 6 00 hr 30 m L.T.	Singapore: The earth tremor was felt half an hour after midnight. The oscillations were from east to west, of very short duration, not exceeding 8 or 10 seconds. The shock was considered as extremely slight, as most of the people did not notice it.		S.F.P. Jan 12, 1843
	Penang: The tremor was also felt in Penang.		A.H.S.

Event	Felt Effect	Intensity MM	Source
1846 May 31 13 hr 30 m L.T.	Penang: A very slight shock of an earthquake, distinctly felt by several persons, occurred in the afternoon between 1 and 2 o'clock shortly after a distinct flash of lightning and a clap of thunder. It did not last above a second or two and appeared to proceed from south to north.		S.T. Jun 1, 1846
	(Remark: May not be of seismic origin)		
1846 Jun 22 (i) 01 hr L.T. (ii) 04 hr 30 m L.T.	Penang: Two smart shocks were felt in the (Sunday) morning, one a little before 1 a.m., the other 1/2 hour before 5 a.m. The vibrations appeared from N to S.		S.T. Jul 8, 1846
1852	Penang: The tremor, described as a very slight one, occurred at 8 o'clock in the morning.	II	S.T. Mar, 1861
1861 Feb 16 19 hr 25 m L.T.	Singapore: The earth tremor was felt at 7.25 p.m. (Sunday evening). "After a trembling motion, which set the glasses in motion on the table, the floor, house and everything it contained commenced to oscillate from south to north, with a regular motion similar to that caused by the swell of the sea. Then three distinct and sharp concussions were felt and the swinging motion ceased. The natives rushed in numbers on to the street in terrified amazement". So wrote a correspondent.	IV	S.T. Feb 23, 1861

Event	Felt Effect	Intensity MM	Source
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According to the Anecdotal History of Singapore, the tremor was felt at Singapore for about a minute; the direction appeared to be from S.W. to N.E. There were two shocks, the undulations being very distinct, and producing in many persons a feeling of nausea and the idea that the house was going to tumble down; doors rattling and hanging lamps swinging about for some minutes. Those who were upstairs ran down.

A.H.S.

Malacca: "...at 8 minutes after 7 o'clock p.m., there was an earthquake. It lasted, I think, about 2 minutes. Never has the oldest inhabitant felt such a severe shock before. Many Chinese shopkeepers and salt fish vendors thought thieves were going to run away with them and all in the house, and began calling out to the peons. A gentleman living in the vicinity of the town had his oil painting thrown down from its pegs; he himself ran out for fear of the house tumbling to pieces", according to a reporter from Malacca.

IV S.T.
Feb 23, 1861

Penang: The earth tremor that began somewhere between 5 to 10 minutes past seven in the evening, was described as "no joke..... as all will admit..... the appalling sensation attendant on that terrifying occur-

Event	Felt Effect	Intensity MM	Source
	<p>rence." "But suddenly.... the island perceptibly roared beneath us and continued its appalling undulations for some four minutes, almost continuously, sometimes abating in severity and then returning with, as it were, renewed force."</p>	IV	S.T. Mar, 1861
	<p>Padang, Sumatra: A violent shock was felt. The vibration lasted for fully two minutes. The shipping in the Straits of Sibirole also felt the quake.</p>		
1861 Feb 23 11 hr 44 m L.T.	<p>Malacca: At about 16 minutes to 12 o'clock another earthquake was felt here. It was fairly strong, but not equal to the previous ones (Feb 16).</p>		S.T. Mar, 1861
1861 April 26 06 hr 00 m L.T.	<p>Penang: An earth tremor was felt at 6 a.m. The shock was described as sharp and distinct, making the venetian blinds shake and rattle. One of the two pendulum time-pieces in a house in the North Beach stopped at 2 minutes past 6. The swords in the guard room at the police office, which were suspended against the wall, moved backwards and forwards and all the gantang and chupah measures rattled.</p>	IV	S.T. May 11, 1861 P.G.
	<p>Province: The tremor was felt between 6 and 7 o'clock. Occasional rattle was heard. "The lamps in the hall were in full swing. The undulations</p>		

Event	Felt Effect	Intensity MM	Source
1873 Aug 19 15 hr 16 m L.T.	<p>were unmistakably east and west, as on the former occasion (16 Feb 1861) ... but never so violent. I felt "sea sickness", according to an informant from the Province.</p> <p>Penang: The earth tremor took place at 16 minutes past 3 p.m. The apothecary standing at the counter, making up prescriptions, was surprised at the undulating tremor of the shocks felt by him. Several houses in Leith Street were shaking and the inmates felt the tremulous shocks.</p>	III-IV	S.T. May 11, 1861
1883 Aug 26 to 28	<p>Eruption of Krakatoa: The explosion of the Krakatoa Volcano was described as the most noticeable occurrence of the kind heard in Singapore. Krakatoa, in the Straits of Anjer, about 500 miles from Singapore, erupted on 26th to 28th August 1883. The noise of explosion was reported heard at a place 12 miles NNW of Kuala Lumpur. Ground shaking was also felt by many people there.</p> <p>Singapore: On Sunday afternoon, the 27th about 5.45 o'clock, a loud explosion was first heard. Faint rumblings and explosions were heard at intervals that evening and during the night. About 11 a.m. on the 28th. a very much louder report was heard, which was the last. When someone in the</p>		P.G.M.A. Aug 20, 1873

Event	Felt Effect	Intensity MM	Source
	Supreme Court suggested that the noise must be occasioned by an eruption, he was laughed at.		A.H.S.
	Selangor: The noise of explosion was heard with extraordinary loudness at a place about 12 miles NNW of Kuala Lumpur. Many people felt the ground shake under the concussions of Monday (28 Aug).	III	S.T. Sept 7, 1883
	(Note: The tsunami caused were twenty-five metres high. It was thought that at least thirty-six thousand natives perished. Fine ash was ejected to a height of more than 20 miles and traversed the world a number of times).		A.H.S. & Sar. G.
1891 Sept 7	Kajang: A large and substantial house, hardly two years old, collapsed. A shock of an earthquake alleged to be felt in the neighbourhood on the day was supposed to have contributed to the accident.		
	(Remark: Doubtful event)		
1892 May 17 20 hr 10 m L.T.	The earthquake which occurred at about 8.10 p.m. was felt all over Singapore, in Johor, Muar, Malacca, Tampin, Jelebu, Penang, Wellesley Province and at Pekan. No damage was reported from any part of the Peninsula. At Muar, a steamer lying at the wharf was moved repeatedly and off Singapore and Johor ships and boats were		

Event	Felt Effect	Intensity MM	Source
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rocked about. The earth tremors were said to be exceedingly distinct and most probably more distinct than those of the Feb 16, 1861 instant. No damage was done in Peninsular Malaysia, but nearly all buildings were shaken, in many cases so violently as to remove loose objects from shelves and tables.

H.N.R. & S.T.
May 18, 1892

Singapore: At Tanmlin it commenced comparatively lightly and increased rapidly in violence till the whole house was violently shaken, so that glasses and furniture rattled and doors kept banging to and fro and then it gradually died away.

IV

The duration of the tremors was very variously reported by observers as from six seconds to three minutes, but no one seemed to have taken an accurate record. At Tanmlin, it seemed to be nearly four minutes before the vibration of the house had entirely died away, according to Mr Ridley. He estimated the violent period at about a minute's duration. One observer at Pasir Panjang noticed two distinct oscillations, the first apparently thirty seconds, the second for about twenty five seconds, there being an almost complete cessation of movement for ten seconds between the two waves.

Event	Felt Effect	Intensity MM	Source
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At Telok Ayer, a lamp glass and ruler shaken off a table on to the floor.

Much alarm was caused to the natives who ran out of their houses and one Chinaman was so frightened that he leaped out of a window and broke his leg.

The effect of the tremor was said to be so marked in Singapore that large buildings, like the Police Baru Courts and the Central Police Station, were shaken; the duration was variably stated as from one to three minutes. An informant at Tanplin Barracks said that the walls, ceiling and floor all appeared to oscillate in concert.

In North Bridge Road, the shocks were alarming enough to send the people running out of their houses in scores.

In certain spots in Singapore, such as Government Hill and Fort Canning, nothing was noticed.

Johor: The tremors were said to be of a more slow and wavy kind.

Tampin: The earth tremor was distinctly felt here. The woodwork at the collectorate creaked with every oscillation so that the sparrows all flew out from their roosting places in the caves.

III

S.T.
May 18, 1892

Event	Felt Effect	Intensity MM	Source
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Penang: The tremors were felt here (also at Wellesley Province) at about 8 o'clock. They lasted from five seconds to two minutes. Many people left their houses in fear.

IV

S.T.
May 18, 1892

(In Deli, Sumatra, clocks stopped, damage was reported. In Rantau Prapat, communication was broken).

Origin Time
1909 Jun 3
18 hr 40 m 48 s
UTC

Epicentre
2.0s 101.0E

Magnitude
7.6

The tremor, originating from an earthquake from the southwest coast of Sumatra, was felt over the southwest coast of Peninsular Malaysia, from Malacca to Singapore. The intensity at several places, e.g. Singapore and Cocob Rubber Estate, Johor was sufficient to awake many people from their sleep. The following were the felt reports from the various places:

Cocob Rubber Estate, Johor: "At about 1.40 a.m., everyone on the estate was startled from sleep by a severe shock, the undulation apparently travelling from east to west. The houses shook violently enough to awaken everyone except a gentleman who enjoys the reputation of being a champion heavy sleeper. All the coolies on the estate were roused and were startled by the violence of the shock, the nature of which could not be mistaken", so wrote a

Event	Felt Effect	Intensity MM	Source
	correspondent from the estate.	IV-V	S.T. Jan 5, 1909
	Malacca: A distinct earthquake tremor was felt in Malacca on Friday morning at a quarter to two. A party of the Rest House, who had not retired, were seriously alarmed. One gentleman, who lived four miles up the coast, was awakened by the shock. Only one shock was felt.	IV	S.T. Jun 5, 1909
	Singapore: The earth tremor occurred at a quarter to two in the morning. No damage was done. Beds and mosquito curtains swayed, almeriahs cupboards rattled, heavy or light and doors creaked and slammed. Pictures were moved out of plumb. Hanging lamps swung and were oscillating for a little time. Water in baths was disturbed into waves. The clocks in the Police Courts stopped at 1.31 a.m. The shocks were felt on vessels in the harbour.	IV	M. Mail Jun 7, 1909
	It appeared there were at least two distinct shocks, which were felt in widely distributed localities. Many residents were awakened from their sleep by the shaking and rumbling, which most people were too sleepy to recognise as an earthquake disturbance. In some cases, however, the disturbance was so marked that there could be no		

Event	Felt Effect	Intensity MM	Source
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doubt about what was happening. Though a good many people slept through the experience, the greater number appeared to have felt the shocks in a lesser or greater degree.

S.T.
Jun 4, 1909

The tremors were apparently most marked on the sea coast in the direction of Tanjong Katong. According to Mr McDonald at Tanjong Rhu, he was awakened by the rattling of windows and doors and, on getting up to investigate, noticed that the whole house was distinctly shaking. The floor undulated, or wobbled to such an extent that it was necessary to hold on to the nearest available support. Coolies from the neighbourhood rushed out of their houses in fear.

A lady in the Hotel Europe said she heard a rumbling sound as though some heavy vehicle were passing in the street below.

(West Sumatra: 230 lives were lost and several villages were destroyed and nearly all the rivers were in flood. The earthquake took place in Upper Padang, Sumatra).

1914 Jun 25
19 hr 07 m 18 s
UTC

Epicentre
4.5S 102.5E

Singapore: An informant from Tanjong Rhu stated that, at 2.13 a.m. in the morning, he was awakened by a sense of uncanny movement amongst the crockery. He found that

Event	Felt Effect	Intensity MM	Source
Magnitude 7.6	all the clocks in the house had stopped at that hour. Residents at Serangoon, Tanglin and Pasir Panjang did not feel the tremor.		S.T. Jun 26, 1914
	(Note: A very severe earthquake had occurred at Bencoolen in Sumatra. Houses collapsed and there were at least eleven dead. The earthquake led to an upheaval of the sea (Tsunami) and a ship, the "Kintuck", (4000 tons) was driven ashore on to a coral reef.	III-IV	M. Mail Jun 29, 1914
1916 Feb 29	Kapar: At 8.55 p.m., two distinct tremors, running east and west were felt here.	II	M. Mail Jul 29, 1916
Origin Time 1916 Jul 27 11 hr 52 m 42.0s UTC	Kapar: An earth tremor was felt at about 6.55 p.m., running north and south, lasting about ninety seconds.		
Epicentre 4.0N 96.5E	Port Swettenham: The shock was also felt here.	II-III	
Magnitude 7.0 PAS	Klang: Mr Li who was lying down in his bungalow reading, felt the tremor for about three seconds. All the lamps and almeriahs in the house were shaking slightly. He ran out of the house with his children, fearing the house might fall.		M. Mail Jul 29, 1916
Depth 100 km			
1922 Jan 31 09 hr 50 m L.t.	The earth tremor, described as minor, was felt in many parts of the Peninsula at 9.50 a.m. It lasted from two seconds to about fifteen seconds.		

Event	Felt Effect	Intensity MM	Source
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Some of the localities where it was felt were Singapore, Muar, Seremban, 16th Mile Port Dickson Road, Klang, Port Swettenham, Kuala Lumpur, Tanjung Malim, Taiping and Kuantan. There is no record that the shock was noticed in Ipoh or Batu Gajah. It was severe enough to cause pictures on the walls to sway and coffee to spill from a filled cup, to cause ornaments to rattle on shelves and cabinets and even to make books fall out of book cases.

A.R.G.S.
1903-1936

M. Mail
Jan 31, 1922

Singapore: The earthquake shock was distinctly felt here by a few people at 9.09 a.m. Desks at the Strait Times building were felt moving. The tremor lasted about two seconds.

II

S.T.
Jan 31, 1922

Muar: The earthquake shock was felt here at 9.05 a.m. Slight damage was done. (No details of what the damage was available).

III

Taiping: The earth tremor was distinctly felt here at 9.16 a.m.

II

S.T.
Jan 31, 1922

Kuala Lumpur: The tremor was felt by people in several parts of the town, namely, the District Hospital, Central Workshops and Federal Hill.

II

-- do --

North Johor: An informant, who was at an estate in North Johor, was startled by a sudden rustling of the trees. There was also

Event	Felt Effect	Intensity MM	Source
	a slight sound like the mutter of distant thunder. However, the coolies in the vicinity seemed to notice nothing. Later his servants told him that his bungalow shook during the earth tremor.	III	S.T. Feb 1, 1922
	North Labis Estate, Johor: A correspondent here informed that a distinct earthquake shock, sufficient to shake a flower pot off a table and rattle the lamps, was felt at 9 a.m.	III	-- do --
1922 Feb 7 12 hr 15 m L.T.	The tremor, described as similar to the one on 31st Jan 1922, was felt at 12.15 p.m. in Singapore, Port Dickson and Seremban.		A.R.G.S. 1903-1936
	The tremor was also felt at the Residency, Kuala Lumpur, Kajang and at Taynton and Segambut Estates.		S.T. Feb 8, 1922
	Batu Pahat: A very distinct shock was felt here at 12.15 p.m. Large buildings shook and subterranean rumblings were quite audible. A sleeping dog in an office was promptly awakened and started barking.	II	S.T. Feb 9, 1922
Origin Time 1926 Jun 28 02 hr 23 m 25.0s UTC	Singapore: The earth tremor was experienced generally here at 10.22 on Monday morning. Some offices and buildings were shaken quite severely. In the Police Courts some rushed out in a hurry. Tables and chairs acted in a most disconcerting		
Epicentre 1.5S 99.5E			
Magnitude 6.75PAS			

Event	Felt Effect	Intensity MM	Source
	manner for quite a few seconds.	III	S.T. Jun 29, 1926
	In the Central Police Station the shaking was just as severe.		
	The tremor was very perceptible on the water front, especially in the wooden offices occupied by the Post Office and shipping departments.		
	In Robinson Road and Cecil Street, people ran out of houses in some excitement.		
	At the Supreme Court, the shock was not felt at all.		
	Port Swettenham: A distinct tremor was felt here at about 10.30 a.m. Tables and other furniture were rocked.	II	M. Mail Jun 29, 1926
	(Note: Reuter news: A heavy earthquake had affected several places in Central Sumatra and there was a panic among the inhabitants. The Governor's residence at Padang and many European houses received severe damage).		-- do --
Origin Time 1926 Jun 28 06 hr 15 m 41.0s UTC	Singapore: Another earth tremor was felt here in the afternoon. It was not as pronounced as the first, which occurred in the morning. However, at Tanjong Rhu, some portions of a chimney in the ship-building yard of the United Engineers were brought down.	III	S.T. Jun 29, 1926
Epicentre 1.0S 99.5E			
Magnitude 6.50PAS			

Event	Felt Effect	Intensity MM	Source
	Port Swettenham: At 1.30 p.m., a distinct shock was felt. Tables and other furniture were also shaken.	II	-- do --
Origin Time 1931 Jan 20 15 hr 26 m 32.0s UTC	Taynton Estate & Sepang: Two slight shocks, 3 or 4 seconds apart were felt at about 10.35 p.m. The shocks shook the informants' houses, caused windows to rattle and water in tongs (barrels) to move.	II	M. Mail Jan 21, 1931
Epicentre 4.0N 91.0E			
Magnitude 6.25PAS			
Depth 150 km	Kuala Lumpur: The shocks were not felt here.		
	Selangor & N. Sembilan States: At about 20 minutes past ten at night, there were two slight shocks separated by about three seconds. Houses were slightly shaken. Most of the people were sleeping and did not feel the shocks.	II	Y.K.P. Jan 23, 1931
Origin Time 1935 Aug 3 01 hr 10 m 01.0s UTC	Port Swettenham: A slight tremor which gave rise to giddiness occurred at about 8.45 a.m.	II	M. Mail Dec 30, 1935
Epicentre 4.5N 96.25E			
Magnitude 7.0 PAS	Penang: Slight tremor was felt here at about 8.30 a.m. Few people noticed it. It lasted for about 30 seconds. The lady athletes, who came from various areas for the MCA Sports Carnival, felt the shock.	II	S.C.J.P. Aug 4, 1935

Event	Felt Effect	Intensity MM	Source
<p>Origin Time 1935 Dec 28 02 hr 35 m 22.0s UTC</p> <p>Epicentre 0.0S 98.25E</p> <p>Magnitude 8.1 PAS</p>	<p>Port Swettenham: The tremor, described as slight, occurred at 10 a.m. and was distinctly felt by many people. It gave rise to giddiness. Window shutters were rocked to and fro. Many people got out of the buildings. The tremor lasted not more than 15 seconds.</p>	II	<p>M. Mail Dec 30, 1935</p>
	<p>Singapore: A slight earth tremor shook several buildings in Robinson Road, Singapore only, at about 10 a.m. A company manager said he and his staff had a strange feeling in the head. The building creaked and shook and the electric fans behaved queerly. His chair shook a little under him.</p>	II	<p>S.T. Dec 29, 1935</p>
<p>Origin Time 1936 Sep 19 01 hr 01 m 47.0s UTC</p> <p>Epicentre 3.75N 97.5E</p> <p>Magnitude 7.2 PAS</p>	<p>Earth tremors, originating from an earthquake over the west coast of Sumatra, were widely felt in the west coastal states of Peninsular Malaysia. Most severely affected were the Klang and Port Swettenham areas. The tremors were also felt at Raub, east of the Main Range.</p>		<p>M. Mail Sept 19, 1936</p>
	<p>In Selangor, Perak and Negeri Sembilan, the earth rocked for about ten seconds at 8.25 a.m. It was considered by people as the biggest earth tremor that they had ever experienced.</p>		<p>S.T. Sept 20, 1936</p>

Event	Felt. Effect	Intensity MM	Source
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Penang: Two distinct tremors were felt here at 8.30 a.m. The Penang Gazette buliding rocked twice for several seconds and a number of clerks downstairs rushed out into the road. Neighbouring buildings were similarly rocked. The quake was also felt in several districts here. (The tremor was one of the most severe felt in Penang). No damage was reported but debris was dislodged in wards from one or two buildings. One man thought he had a fainting attack. Another resident in Campbell Street thought the roadway was sinking.

III

M. Mail
Sept 19, 1936

Slim River: A planter was amazed when acres of rubber trees shook together, while leaves rustled violently although there was no wind.

IV

M. Mail
Sept 9, 1936

Frazer's Hill: Earth tremors, lasting for several seconds, shook the Selangor Club buildings, the Rest House and private residences on the hill. Considerable alarm was caused among residents here. People rushed out of their houses. In some cases, people were thrown off their feet. Beds slithered along the floor and crockery rattled.

IV

The Selangor Club bungalows were shaken and, as the buildings swayed, doors rattled and pictures fell from the walls on to

Event	Felt Effect	Intensity MM	Source
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the floors.

At Whitlington, in Maxwell Road, the tremors were most severe; the staff, alarmed, ran helter-skelter out of the bungalow. Two European women residents snatched up their babies and dashed out of bed when they felt the room move.

A lady resident at a Selangor Club bungalow felt the room move. "The tremors caused me to stumble", she said, "and it seemed as if the walls were going to collapse". She rushed out of the room and noticed that several other people were also running along the passage. Someone shouted "get out of the building quickly".

At St Margaret's School, the tremors were felt. When the tremors first started, one little girl fell from her chair. Tables moved and cups and saucers rattled.

Gap: The tremors were very noticeable here. A glass containing a drink moved along the counter.

IV

Kuala Lumpur: The tremors were felt widely in the town. At Petaling Hill district, a resident, who was holding a cup of coffee in his hand while the tremors occurred, had some of his coffee spilled. There was an ominous creaking of the

Event	Felt Effect	Intensity MM	Source
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stairs which lasted for a couple of seconds. (Some said it lasted for five or six seconds).

IV

The offices of the Malay Mail rocked disconcertingly for several seconds during the second and most severe period of the shock. Heavy book-cases swayed sickeningly and clocks stopped. Occupants rushed out of the building. The tremors were not felt by many of the nearby pedestrians, apparently.

A Malay syce (groom), seated in a Baby Austin car outside a house in the Racecourse area, thought that someone was shaking the car.

At the Police Depot, minor cracks occurred in some walls and there was fall of pieces of masonry.

At the Bukit Bintang Amusement Park, several of the temporary buildings were shifted slightly. In the Oriental Building, a brick partition wall was cracked.

At Cheras Estate a couple, seated on the cement floor beneath the bungalow, heard a curious creaking in the wood-work above them. The building swayed visibly. The shock lasted for about 5 seconds.

A European gentleman was having breakfast when his chair heeled over 25

Event	Felt Effect	Intensity MM	Source
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degrees. "It was more than a tremor. It was a definite rock. We have had tremors here before but never a quake like this," he said. Pictures and ornaments clattered to the floor.

An M.C.S. Officer who was getting up from his breakfast table, was thrown back into the chair. Before he could recover, plates crashed to the floor, and his table danced about on two legs.

Malays, Chinese and Tamils in the town were said to have run excitedly into the streets shouting "The earth is rolling".

Tanjung Malim: The tremor was felt here for three to four seconds. At a training college, there were only a few students at the time of occurrence. Seeing things beginning to sway and hearing the roof of the main hall creaking, they got out of the building hastily.

IV

Raub: The earth tremor was felt here for three to four seconds.

Kajang: The earth tremor was also felt here.

Sungei Choh Estate, Rawang: The manager felt the tremor when he was seated in his office. He heard the factory building creak and a number of sheets of galvanized iron

Event	Felt Effect	Intensity MM	Source
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rattled ominously. The table at which he was sitting moved about half an inch; yet a coolie standing three or four yards away outside the office felt nothing.

III

Klang and Port Swettenham: The tremor was felt here with particular severity. Large crowds rushed into the streets. One European lady was thrown from her chair onto the ground.

V

Kajang: Residents felt the tremor for about 10 seconds. They all rushed out of their houses and shops to safety. The O.C.P.D. Kajang, who was inspecting kit, was thrown off his balance and frames on the wall swung from side to side. Buildings shook for several seconds. Rubber tappers had to stop work, wondering what had thrown them off their balance.

IV

Singapore: The tremor was scarcely noticed here or else regarded as the vibration of passing traffic. No alarm was caused.

III

In the Union Building in the city, hanging electric lights were set swinging. The tremor gave rise to a slight giddy sensation.

A motorist sitting in his car preparing to start it felt his vehicle "buck" slightly.

Event	Felt Effect	Intensity MM	Source
1942 May 24 03 hr 26 m 30 s UTC Epicentre 5.0N 96.5E Magnitude 6.75PAS Depth 60 Km	Kuala Lumpur: A distinct earth tremor, which lasted about 10 to 15 seconds, was felt here at about 12.30 p.m. (Nippon Time) Workers in the Malay Mail Office felt the building shake distinctly and desks and almeriahs moved.	II	
1948 Jan 13 10 hr 50 m L.T.	Singapore: A slight tremor, lasting about five seconds, occurred at about 10.50 a.m. Most of the people here did not feel it. It was felt by the residents in Tiong Baru, Medor and Orchard Roads. People on upper floors of high-rise buildings felt the tremor most severely.	I-II	S.C.J.P. Jan 14, 1948 S.T. Jan 14, 1948
1948 Aug 24 15 hr 45 m L.T.	Teluk Anson: A slight and short earth tremor was felt here at 3.45 p.m. No damage was done to buildings.	II	S.T. Aug 28, 1948
1948 Dec 28 22 hr 30 m L.T.	Singapore: Strong earth tremors, lasting for about 30 seconds, were felt all over the western side of the island and to a lesser degree in Singapore itself at about 10.30 p.m. Vases in the home of a charge engineer began to dance and the entire hill was felt shaking. He said it definitely was a strong earth tremor. "It put the wind up me", he declared. Another resident described the tremor as "very strong". "The whole bungalow shook in a backwards and forwards motion for about 30 seconds", he said.	III	F.P. Dec 29, 1948

Event	Felt Effect	Intensity MM	Source
1949 Mar 10 12 hr 00 m L.T.	<p>Another resident said there were bumpings and shaking as if the earth were shifting beneath him. Officers writing in the mess on an adjoining island felt the chairs they were sitting on start to tremble and move. Another resident felt his legs begin to tremble and felt as if someone were trying to remove his cushion. The tremor also set off a burglar alarm. There were no reports of any damage, however.</p> <p>Singapore: An earth tremor, which lasted for a few seconds, was felt in parts of Singapore just after noon. The tremor, which was not severe, was experienced in the Straits Times Office and nearby offices.</p>	II	S.T. Mar 11, 1949
Origin Time 1952 Mar 15 11 hr 15 m 47.0s UTC	<p>Singapore: A 10-second earth tremor was felt in the southern part of the island about 6.50 p.m. No damage was reported. A merchant, sitting in his room, felt the floor shake. Then the calendar moved to the left and the building shook for some seconds. Two other residents from another area reported that the earth shook for several seconds' duration. One said his typewriter shook from side to side. The other said he had to stop typing on three occasions because of "violent shakes".</p>	II	S.T. Mar 16, 1952
Epicentre 3.10S 102.40E			
Magnitude 6.25ROM			

Event	Felt Effect	Intensity MM	Source
Origin Time 1962 Dec 31 11 hr 01 m 04.4s UTC	Singapore: A slight tremor was felt by a few people in several parts of the city at 6.35 p.m. It lasted a few seconds. One resident said he suddenly felt giddy, while a ceiling fan began to swing about. His neighbour, a woman, was standing in front of her house. She suddenly lost balance and knocked her head on the doorway.	II-III	S.T. Jan 1, 1963
Epicentre 0.50N 99.9E			
Depth 67 Km			
	Kuala Lumpur: A number of people here also reported feeling the tremor.	II	
Origin Time 1967 April 12 04 hr 51 m 39.4s UTC	Earth tremors caused high buildings in five Peninsular Malaysia towns to sway alarmingly (at 12.25 p.m. L.T. 12th April 1967), and panic-stricken people left them in a hurry.		S.T. Apr 13, 1967
Epicentre 5.26N 96.4E			
Magnitude 6.1MB			
Depth 45 Km	Penang: Hundreds of government employees rushed out of a nine-storey building. An officer on the 8th floor of the building said that he suddenly "felt funny" and thought that he was having a heart attack. He soon realized it was an earthquake when he saw picture frames swinging on the wall. Other officers and clerks also rushed out of their rooms.	IV	-- do --
	In the Penang High Court, the Justice felt the building swaying. Downstairs, in the Magistrate's Court, the defence council initially thought someone was shak-		

Event	Felt Effect	Intensity MM	Source
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ing the bar table. Everyone cleared out of the building.

At the new Penang Port Commission building in King Edward Place, one of the walls was noticed starting to crack. Thinking that the building was going to collapse, everyone ran out. People in various parts of the town also rushed excitedly out of their houses when they felt the ground shaking. City Council workers ran out of their building, fearing that the building, built in 1879, would collapse.

The old Central Market, (converted into a store) was the only building badly damaged. The facade (a wall) collapsed.

A bed on the fourth floor of the Penang General Hospital was found shaking. The doors of the ward and ceiling fan swayed.

Several reports of cracks in buildings were received, but the cause was not ascertained.

(Tremors was also felt in Butterworth).

Alor Star: A doctor, at a clinic 50 yards from a railway crossing, thought that a train was passing. He realized that it was an earthquake when no sound was heard.

III

Event	Felt Effect	Intensity MM	Source
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Ipoh: The two four-storey Federal Buildings shook for more than a minute and office workers rushed downstairs. Pictures on the wall on the top floors were swaying.

II

(The tremors were also felt at Teluk Anson and Taiping).

Parit Buntar: Cracks appeared in the cement floor of the District Office. Housewives rushed out of their houses.

Kuala Lumpur: The tremors were felt in several tall buildings in various parts of the town for about a minute. Workers in the nine-storey Government building in Gurney Road ran out in panic.

II

(Note: This earthquake, centred at North Sumatra, killed 14 people and destroyed about 2000 houses and ravaged crops. It claimed a further unknown number of casualties when it caused a train to roll off its tracks, according to a Jakarta report).

Origin Time
1967 April 12
19 hr 33 m 47s
UTC
Epicentre
5.27N 96.76E
Magnitude
5.2MB
Depth
58 Km

Tanjung Malim: Earth tremors were felt here at about 1 a.m. L.T. 13th April 1967. The zinc roof of a house was heard rattling. At a neighbouring house, the bed was said to shake violently for about 20 seconds.

I-II

S.T.
Apr 14, 1967

Event	Felt Effect	Intensity MM	Source
Origin Time 1967 Aug 21 07 hr 33 m 0.6s UTC	Penang: A mild tremor was felt at about 3.15 p.m. L.T. It lasted only a few seconds. Occupants of the top floors of a nine-storey and an 11-storey building rushed into the open. The tremor was felt by occupants from only about the fourth floor upwards.	I	S.T. Aug 22, 1967
Epicentre 3.6N 95.8E			
Magnitude 6.1 MB			
Origin Time 1969 Nov 21 02 hr 05 m 35.3s UTC	Penang: Three tremors within two-and-a-half minutes were felt here, the first at about 9.40 a.m. L.T., the second and third small ones at one-minute intervals later. Occupants of a nine-storey building ran into the open. In the Penang City Council, an officer felt giddy, as if he were moving. A 5th storey flat occupant saw chairs moving in the hall. Apart from minor cracks under several windows in one of the blocks of flats, no other damage was reported.	II	
Epicentre 2.07N 94.65E			
Magnitude 6.4MB			
	Butterworth: A slight tremor was felt at the District Office at about 9.40 a.m. The District Officer felt giddy.	II	
	Ipoh: Workers in the Education Department and the Federal Building felt the tremor and dashed out. Occupants of a 15-storey building, however, did not feel anything.	I	
	Kuala Lumpur & Petaling Jaya: The tremor was felt in two multi-storey buildings. An officer on the		

Event	Felt Effect	Intensity MM	Source
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sixth floor of one of the buildings said the tremor lasted about three minutes. He felt giddy and then saw the building swaying slightly. The tremor affected the building from the third floor up. Workers were told to get out of the Petaling Jaya Government building.

I

1970 May 13

Kota Baru: A slight earth tremor was felt by residents and office workers in the Pengakalan Chepa area, about 6 miles from Kota Baru. It occurred at 12.37 p.m. and shook the airport control tower, the meteorological building and other nearby houses.

S.T.
May 13, 1970

(Remark: Doubtful case)

Origin Time
1971 Feb 04
15 hr 33 m 28.6s
UTC

Epicentre
0.64N 98.83E

Magnitude
6.3 MB

Singapore: Most parts of the island were affected. Many people left their high-rise houses with the first shocks, at around 11.10 p.m. L.T. They reported feeling the tremors for 30 seconds to a full minute. Mended cracks in these flats were re-opened and, in some cases, widened. Some occupants in high-rise areas were awakened from sleep. A clerk, who was upstairs in his two-storeyed shop house, felt a sensation "like the floor sinking two inches".

III

S.T.
Feb 5, 1971

Another clerk, living in a two-storey house, said the whole house shook quite violently three times,

Event	Felt Effect	Intensity MM	Source
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each time lasting about three seconds.

At Singapore Airport, the checking-in counters trembled. Many thought a plane had crashed.

Kuala Lumpur & Petaling Jaya: Most of the multi-storey buildings felt the tremor. Occupants left their houses in panic. One high-rise flat dweller said he felt the table moving for a few seconds and his plate slipped off. The tremor was felt by a few at least on lower ground. The movement lasted several seconds.

M. Mail
Feb 5, 1971
&
S.T.
Feb 6, 1971

Other areas: Minor tremors were felt at Penang, Taiping, Ipoh, Telok Anson, Ulu Kinta, Kapar, Malacca, Negeri Sembilan, Kuantan and Johor Bahru, mainly by occupants of multi-storey buildings.

II

Origin Time
1972 Dec 18
13 hr 57 m 03.8s
UTC
Epicentre
1.83S 99.65E
Magnitude
5.6 MB

Singapore: A minor tremor lasting two to three minutes was felt in some areas at about 10.10 p.m. Several hotel employees felt giddy. The tremor did not cause any cracks or damage.

S.T.
Dec 19, 1972

I-II

Origin Time
1975 Jan 8
01 hr 58 m 55.1s
UTC
Epicentre
3.0S 101.78E
Magnitude
6.0 MB
Depth
95 Km

Singapore: Tremors shook several blocks of high-rise flats and sent hundreds (600) of frightened residents dashing out for safety. The tremors lasted about two minutes. According to these residents, they felt giddy when the tremors

S.T.
Jan 9, 1975
S.C.J.P.

Event	Felt Effect	Intensity MM	Source
	occurred.	II	Jan 10, 1975
Origin Time 1976 June 20 20 hr 53 m 13.4 s UTC	Penang: An earth tremor, which started at about 4.30 a.m., shook some high-rise buildings here and sent some panic-stricken residents rushing to the ground floor. The tremor lasted about three minutes. Some residents were awakened from their sleep by giddiness and a sense of things moving about in their rooms. The tremor was most felt from the third floor upwards. A businessman, living on the 16th floor of a flat, said that he was awakened by something pushing his bed from left to right. He felt the building shaking like a ship during a storm.	II	S.E. Jun 22, 1976
Epicentre 3.40N 96.32E			
Magnitude 6.3 MB			
Depth Normal			
	Kulim, Kedah: Several residents reported that they too felt the tremor. They were awakened by the swaying of their houses. No damage was reported.	II	N.S.T. Jun 22, 1976
	(The quake's epicentre was located in the Indian Ocean about 120 km west of Banda Aceh. It was felt over a 508 km stretch of Sumatra, from Banda Aceh to Medan.)		N.S.T. Jun 22, 1976
1976 July 28	Singapore: Several people working in the Vosper Thornycroft Shipyard in Tanjong Rhu felt a minute of intermittent earth tremors at about 10.30 a.m. A contract manager felt his office shaking slightly. A secretary saw		

Event	Felt Effect	Intensity MM	Source
	her rubber stamp stand vibrating on the table. A design manager felt the floor move for about one or two seconds.	I	S.T. Jul 29, 1976
	(Remark: The tremor may not have been of earthquake origin)		
Origin Time 1977 Mar 8 23 hr 14 m 28.0 s UTC	Singapore: A slight tremor was felt at around 6.50 a.m. Hundreds of people in high-rise flats ran out into the streets after being awakened by the crash of falling objects in their rooms. Most of them felt their flats moving for about a minute, at around 6.50 a.m.		M. Mail Mar 9, 1977 & N.S.T. Mar 10, 1977
Epicentre 0.45N 100.02E		II	
Magnitude 5.5 MB			
Depth 22 Km	Kuala Lumpur: The first tremors were felt shortly after 6.47 a.m. Many residents of high-rise flats were barely awake, when they heard windows and crockery rattle and tables and chairs shake. Others slept through it all.	II	
	Malacca: The slight tremors, lasting about 10 seconds, were felt by residents at various places at about 6.48 a.m.	II	
	Muar: The tremors were also felt by people at their breakfast tables in several areas. A man riding a motorcycle was thrown off. Some crockery fell off shelves. Some houses swayed. Water in ponds and containers stirred violently. Many who felt the tremors		

Event	Felt Effect	Intensity MM	Source
	reported getting headaches.	III	
	Johor Baru: Several residents of a 14-storey block of flats felt the building shake. Some rushed downstairs.	I	
Origin Time 1979 Mar 16 17 hr 36 m 59.10 s UTC	Penang: An earth tremor occurred here at about 11.10 p.m. but most people were unaware of it. At a multi-storey hotel, some employees felt the tremor, which occurred twice within a few seconds. One employee, who was working on the eleventh floor, said he suddenly felt giddy and saw lamps swinging.	I-II	N. Sun. T. Mar 18, 1979
Epicentre 5.23N 96.33E			
Magnitude 5.6 MB			
Depth Normal			
	A resident nearby thought a passing lorry had caused her house to 'tremble'.		
Origin Time 1980 April 1 16 hr 21 m 48.1 s UTC	Penang: The mild tremor was felt in various parts of the Island. Several guests of some hotels were awakened from sleep. The tremor, which occurred about 11.30 p.m., lasted for a few, to more than 10, seconds. Guests on upper floors rushed out of hotels when they felt their beds shaking.	II	N.S.T. Apr 3, 1980 & T. Star Apr 3, 1980
Epicentre 4.03N 97.56E			
Magnitude 5.6 MB			
Depth 41 Km			
Origin Time 1982 Feb 24 04 hr 22 m 40.3 s	Penang: The earth tremors, lasting less than 40 seconds, were mostly felt on the upper floors of high-rise buildings in various parts of the island, shaking chairs and tables on upper floors, sending thousands rushing		
Epicentre 4.37N 97.76E			
Magnitude 5.4 MB			

Event	Felt Effect	Intensity MM	Source
Depth 53 Km	down to the streets. The tremors were felt twice, the first tailed off after 30 seconds and was then followed by the second. (Workers, especially those on the first and second floors of the New Straits Times Office, also felt the building rocking). There were some areas in the island where the tremors were not felt at all.	II	Feb 25,
	Kuala Lumpur: The tremors was not felt at Kuala Lumpur or Petaling Jaya. Only an official from the Meteorological Office noticed that the building shook slightly.	I	
Origin Time 1983 April 04 02 hr 51 m 34.3 s UTC	Penang: The tremors were felt on the upper floors of high-rise buildings. Windows rattled and buildings shook. People on higher floors felt giddy. Pictures on walls moved.		
Epicentre 5.72N 94.72E	The majority of people in the island, especially those in the streets, did not notice the tremors.	II	N.S.T. Apr 5, 1983
Magnitude 6.6 MB			
Depth 79 Km	Petaling Jaya: The tremors were felt in several high-rise buildings for about 20 seconds.	II	T. Star Apr 5, 1983
	The tremors were also felt in Kedah, Perlis and other west-coast states.		
	(Note: The earthquake rocked the capital city of Banda Aceh in North Sumatra, injuring at least 100 people and damaging many buildings).		

SABAH AND SARAWAK

Events	Felt Effect	Intensity MM	Source
1874 June 26 02 hr 00 m L.T.	<p>Simunjan: About 2 a.m., on the morning of 26th June, a smart shock of an earthquake was felt here, which appeared to last about ten seconds; the direction of the wave was from west to east. The people in the village were in great fright, children screaming, fowls waking up, dogs howling etc. No damage was done.</p> <p>(According to the oldest inhabitant, there was a slight shock 70 years ago (before 1874). According to the Europeans in Sarawak, there had not been any earth tremors for the last thirty odd years (before 1874).</p>	III-IV	Sar. G. Jun 26, 1874
1876 June 24 19 hr 10 m L.T.	<p>Kuching: A shock of an earthquake was felt here at ten minutes past seven on the evening of the 24th of June 1876. This shock was very slight and did not last more than two seconds and felt very "like the vibration of an old West-end house in London when a heavily laden wagon drives past".</p>	III	Sar. G. Jun 1876
1883 Aug 26 to 28	<p>Kuching: Earth tremors originating from the Krakatoa eruptions were felt here. (No further detail was available). Note: The felt effect in Peninsular Malaysia due to these eruptions is described in the preceding section.</p>		S.T. Nov 20, 1953

Events	Felt Effect	Intensity MM	Source
1884 Feb 14 20 hr 05 m L.T.	Kuching: At about 5 minutes to 8 o'clock on the 14th night, a slight shock of earthquake occurred on the Perrissen Road. A loud report, like an explosion from the north, was instantly followed by a vibration which shook the whole house, causing the lamp and glasses to rattle. The shock was also felt at Sentah (5 miles away).		S.T. Feb 18, 1884
	(Remark: May not be seismic in nature)		
1884 Feb 18 17 hr 00 m L.T.	Kuching: At 5 o'clock in the evening another shock was experienced though not so severe as on the 14th instant. This time it was as if a light carriage had been driven under the house and the sound travelled from north to south and lasted about two seconds. The shock was also felt at Sentah.		-- do --
	(Remark: May not be seismic in nature)		
Origin Time 1897 Sept 21 05 hr 12 m 0.0 s UTC	Sandakan: Two shocks of earthquake were felt at 1.10 p.m. They were severely felt in the houses throughout the settlement - almost as strongly in the Club as in the house on the hill. The town clock was stopped by the shock. A narrow fissure in the ground extended from Jalan 4 crossing under the Government Offices close to the clock tower, over Baru Hill across the road at		
Epicentre 6.0N 122.0E			
Magnitude 8.7 CFR			

Events	Felt Effect	Intensity MM	Source
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the back and into the reserve between Leila Road and the Chinese temple. A good many people were alarmed, but the only damage done appeared to be to one house, the wall of which was cracked.

An officer from the Borneo Company's sawmill wrote: "...the hill on which my house stands was considerably affected the shock which occurred about 1.15 p.m., I first became aware of it by a swinging motion of the whole house lasting .. about one minute I found two crevices starting about 3 feet apart on the western slope of the hill and opening out more or less irregularly to 15 to 25 feet apart and continuing ... up to the upper level of the hill, losing themselves in the lawn. The path by the N.E. of the house was cut up into some 10 to 12 different splits over a distance of 9 feet. The average opening or crevice was about 1/2 inch; the ground surface between the two crevices for nearly the whole length had sunk."

Kudat: The earthquake shock was described as slight. Several distinct tremors from east to west were observed, lasting 15 seconds. Some damage was done in the town at the godowns warehouses of two companies.

Events	Felt Effect	Intensity MM	Source
	Sugat and Labuk: The shock was felt distinctly here.	VI	N.B.H. Oct 1, 1897
	Labuan: The earthquake caused a fissure to appear in a road and under the Government Office here. In Brunei Bay, near Labuan, an island appeared, accompanied by mud volcanism.	V	J.M.
	Note: 1. In the afternoon following the about earthquake, an island (mud volcano) appeared off the Klias coast. A mud crater formed in the centre of the island and gas escaped from many clefts and holes.		J.M.
	"The islet, near Kudat on the North Borneo coast, was lately named Ruby Island. It is rectangular in shape, 360 feet long and 300 feet in breadth."		S.T. Jan 15, 1898
	2. "About the same time as the earthquake, a new island was thrown up from the sea between Mempakul and Lambeidan, fifty yards from the mainland, oposite Labuan. The island is of clay and rocks and measures 200 yards long by 140 yards broad and 60 feet high. The island appears to be increasing in size and emits inflammable gas in several places, with a strong smell of petrol gas", reported the Straits Times, Sept 25, 1897.		

Events	Felt Effect	Intensity MM	Source
1902 April 5 20 hr 00 m L.T.	Tawau: The earthquake shock occurred at about 8 p.m. It was described as somewhat severe according to Mr W.W. Wells. It appeared to come from the southwest and lasted several seconds. The police gong at the Government Offices was set striking and many of the inhabitants rushed out of their houses.	IV	B.N.B.H. Apr 16, 1902
1902 April 10	Semporna: On the night of Thursday the 10th, while a ship, "S.S. Labuan", was anchored here, a noise as of distant thunder proceeding from the direction of Tawau was heard and, simultaneously, a quivering vibration was felt throughout the ship. The informant commented: "We are inclined to the belief that this peculiar incident was also a seismic shock for, although a sharp clap of thunder overhead will often cause buildings and ships underneath to vibrate, a distant clap very seldom, if ever, has this effect. Moreover if this was a clap of thunder, it was a single solitary one".		B.N.B.H. Apr 16, 1902
1903 May 2	Tawau: A mild earthquake shock was experienced here on the evening of May 2. (No further detail was available).		B.N.B.H. May 16, 1903

Events	Felt Effect	Intensity MM	Source
1908 Dec 31 09 hr 05 m L.T.	Tawau: The earthquake shock was experienced at the Sabatik Coal Depot. The shock caused the ship, "S.S. Victoria," which was coaling at the time, to heel over so much that Capt. Eckhert thought there had been some accident, while the heap split in several places. A loud report was heard to the southward.	V	B.N.B.H. Apr 1, 1909
Origin Time 1909 May 15 (a) 20 hr 40 m L.T. (b) 21 hr 00 m L.T. (c) 1909 May 16 02 hr 00 m L.T.	Tawau: Earthquake shocks were experienced in the District. There was a slight one at 8.40 p.m. and a second at 9 p.m., rather more severe. A third shock, very slight, was felt at about 2 a.m. on May 16 (Sunday). No damage was done.	V	B.N.B.H. Jun 1, 1909
	At Sebatik Coal Depot, opposite the mouth of the Serudung River, there were 6 severe shocks the same night, with very little damage except to crockery. At Silimpopon No. 1 Station, the wharf was reported to have swayed so much that some coolies on it was nearly thrown into the water; the coal heap fell down in quantities and tins in a godown store were thrown across the room. No damage was done in the pits but workers came to the surface in a great hurry.		

Events	Felt Effect	Intensity MM	Source
1910 Mar 7 09 hr 00 m L.T.	Simanggang, Sadong and Kuching: Between 8.55 and 9 a.m. on the morning of the 7th an earthquake shock, which lasted about half a minute, was felt in Simanggang, Sadong and by many in Kuching.		
	At Simanggang the shock was very distinctly felt and caused some alarm.	III	
	At Sadong the movement was felt only on the low ground and neither on Ngli Mountain nor in the mines.	II	Sar. G.
1910 April 7	A slight shock of earthquake was generally felt all through the second and third divisions in Sarawak in the early morning.	III	Sar. G. May 2, 1910
1911 July 27	Ranau, Tambunan District: A slight earthquake was felt here. (This is the third within six years, according to the report).		B.N.B.H. Sept 1, 1911
1912 June 6 17 hr 35 m L.T.	Timbang Batu, Marudu: The earthquake shock was felt here at 5.35 p.m. The shock travelled with the usual booming sound, its direction being NE to SW. There were only the sound and tremors, no undulations being perceptible.	III	B.N.B.H. July 1, 1912
1913 Aug 14	Tawau: The earthquake shock was felt here on the morning of Aug 14. (No further detail was given).	III	B.N.B.H. Oct 1, 1913
1914 Feb 24 04 hr 00 m L.T.	Lahad Datu: The earthquake shock was felt in the District of Lahad Datu at 4 a.m. No damage was done.		B.N.B.H. Apr, 1914

Events	Felt Effect	Intensity MM	Source
1915 Sept 1 4.45 a.m. L.T.	Tawau: The Acting District Officer of Tawau in a letter to the Resident, East Coast, Lahad Datu on Sept 8, 1915 had reported that "three somewhat severe earthquakes, had occurred at the given times. The latter shock caused some little excitement among the staff in his office. The office building and heavy safe oscillated violently. The only damage was in the cement bedding of the station flagstaff".	IV	Sabah State Archive Colonial Record
Sept ? 5.15 a.m. L.T.			
Sept 8 3.15 p.m. L.T.			
1916 Feb 10	Timbang Batu, Marudu: The earthquake shock was felt here at about 8.15 p.m. The District Officer's house shook violently for about 15 seconds. Down at the foot of the hill, the sergeant reported that the same thing had occurred at the barracks and in the goal, and all the Chinese shopkeepers also reported that their shops had been shaken. At Bonton Estate, which is some 4 miles north of the station, Mr Brook, the manager reported a similar occurrence at about the time stated. He described it as follows: "At about 8.15 and 8.30 p.m., I distinctly heard two loud reports over the top of my house which sounded like the explosion of a cannon. All rushed outside to see what tree had fallen on the house. Finding nothing amiss, I again entered the house and then immediately experienced a violent		

Events	Felt Effect	Intensity MM	Source
	<p>shaking of the whole house which lasted for about 30 seconds". He described the shaking as "having started in the top of the house and run downwards". All the coolies at the Estate bore out this statement, though they did not seem to notice the two loud reports.</p>		
	<p>The shock was also felt at Ranau Estate. However, at Pengkalan Bandar, which is situated between Bonton and Ranau, nothing was felt.</p>	V	<p>B.N.B.H. B.N.B.H. Mar 1, 1916</p>
1920+	<p>Mempakul: It was reported that "in a Herald of former years of an earthquake whereby between Mempakul and Lumbidan, part of the sea-bed was upheaved forming a new island".</p>	V	<p>B.N.B.H. Jan 16, 1933</p>
<p>1923 April 9 03 hr 09 m 08.0 s UTC</p>	<p>Cowie Harbour, Tawau: An earthquake shock, described as of a quite unusual severity, was felt all over Cowie Harbour, from all accounts, on April 19 at 11.15 a.m., lasting about 20 seconds. It caused general alarm. Everyone rushed out of his dwelling to avoid being entombed by what he thought was going to be the collapse of his house. Nothing happened however.</p>		
<p>Epicentre 2.50 N 117.5 E</p>			
<p>Magnitude 7.0 PAS</p>	<p>The informants were in a launch more than half way to Sebatik and noticed at about the same time a curious disturbance, like a heavy swell, lasting</p>		

Events	Felt Effect	Intensity MM	Source
	only a few seconds, in a place where it was usually as calm as could be.	V	B.N.B.H. Mar 16, 1923
	(Note: The above shock was followed by another shorter and less severe one an hour later and two minor ones on the 23rd and 24th April 1923).		
Origin Time 1923 April 19 03 hr 09 m 08 s UTC	Tawau: "All the town's people ran out into the street and the wharf - at that time, of timber - resembled a sea serpent until it righted itself", as described by the Government Secretary, Sandakan.		Colonial Correspon- dence 10.12.1932 Sabah Archives
Epicentre 2.5 N 117.5 E Magnitude 7.0 PAS			
1923 Aug 11 00 hr 54 m 25.0 s UTC	Tawau: The earthquake shock, more severe and of much longer duration than that experienced on April 19, 1923, occurred at about 9 a.m. here, lasting for about a minute. However, no damage was done but there was a fair amount of panic.	V	B.N.B.H. Sept 1, 1923
Epicentre 4.5 N 119.5 E Magnitude 6.5 PAS			
	Lahad Datu: The earthquake shock, lasting 30 seconds, was felt here at 8.50 a.m. The informant, sitting in his office at the time of the first indication of the disturbance, felt a slight tremor beneath his chair. It was followed by a severe shaking and swaying of the whole building, causing the windows to rattle and the roof beams to creak in an ominous manner. His clerk dashed out of the office. Trees and bushes outside were dancing and swaying, a		

Events	Felt Effect	Intensity MM	Source
	fascinating effect that held the informant spell-bound for some seconds, quite regardless of any danger. As he got up to leave the office, the quaking ceased.	VI	B.N.B.H. Sept 17, 1923
	Note: Another shock took place an hour later but it lasted only a few seconds and caused little or no excitement.		B.N.B.H. Sept 1, 1923
1928 Jan 25	Bengkoka, Marudu Bay: Two distinct earthquake shocks were felt here at about 1 a.m. on Wednesday 25 th January 1928. On Pitar Estate, the shock was reported to be "so severe that the coolies enmasse fled in terror for their lives". (According to the same report, "Mr. Metelerkamp of Senaja, who had been 34 years in the bay, had never before heard of an earthquake in these parts or anything resembling one".)	V	British North Borneo Herald Mar 16, 1928
1932 Mar 7	Pingan-Pingan: A considerable earthquake shock, lasting several seconds occurred here at Pingan-Pingan.		B.N.B.H. Mar 16, 1932
	Sandakan: A slight but distinct earth tremor lasting perhaps for half a minute was felt here soon after 4 p.m.	III-IV	B.N.B.H. Feb 1, 1933
1932 Oct 17 (a) 16 hr 45 m L.T. (b) 17 hr 50 m L.T.	Keningau: An earthquake shock was felt by all in the Keningau Station and shops at 4.45 p.m., October 17. Another shock was felt at 5.50 p.m. on		B.N.B.H.

Events	Felt Effect	Intensity MM	Source
	the same day.		Nov 16, 1932
i) Origin Time 1932 Dec 4 08 hr 11 m 12.0 s UTC	Tawau: An informant wrote from Tawau, "We have experienced a number of earthquake shocks and tremors lately, the most severe being at about 4.10 p.m. on Sunday December 4 th , we understand this particular shock has been felt elsewhere in Borneo. Here the severity was considerable. Bottles, cups and pictures all being reported broken".		
Epicentre 2.5 N 121.0 E			
Magnitude 7.1 PAS			
ii) Origin Time 1932 Dec 4 10 hr 32 m 57.0 s UTC	Two earthquake shocks were felt in Tawau, one fairly severe at 4.10 p.m. and second slight at 6.40 p.m.	V	B.N.B.H. Feb 1, 1933
Epicentre 2.25 N 121.0 E			
Magnitude 6.75 PAS	Sandakan: The earth tremor was distinctly felt by the then Government Secretary of Sandakan.		Colonial Records Sabah Archives
1932 Dec 13	Sandakan and Tawau: Earthquake tremors were felt at both places.		
1937	Sagut & Labuk: Two earthquake shocks were felt distinctly on the Sugat and Labuk. At the latter station the Sergeant, who was in the office at the time, supposed that the officer-in-charge was testing the stability of the office tiangs.	III	B.N.B.H. Oct 1, 1937
1939 Sept 7	Bukit Karang Limau, Mempakul: A minor earthquake occurred at Bukit Karang Limau, near Nosong Point on the night of 7 th September. A visit was made by the then Assistant		

Events	Felt Effect	Intensity MM	Source
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District Officer to the part of the disturbance on the 18th. He reported that "the coastline has been pushed out into the sea and the original beach is covered by a bank of mud, coral and stones some 40 feet high and 15 chains long. The original hill rises steeply to a height of one hundred and fifty feet and is covered with jungle. Entering this it was at once apparent that several shocks must have occurred for the hill side was rent open, parts of the ground having sunk and other places risen so that trees normally perpendicular were leaning at all angles and in some cases were split from top to bottom. As we penetrated further it was noticed that old stream had dried up having been "tilted" or blocked by miniature land slides. Near the top of the hill the ground had assumed a peculiar wave-like formation the slopes of which were quite high and steep in many cases and difficult to climb.

But it was the summit of the hill which presented the most extraordinary sight of all. From the gloom of the forest we emerged suddenly into sunlight and an open "sea" of dried mud, about 2 1/2 acres in area. There was no sign of the jungle that had grown there originally; it had been engulfed. Hearing strange

Events	Felt Effect	Intensity MM	Source
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gurgling sounds we saw pools of muddy water bubbling strongly and found that this was due to the escape of gas under pressure. Where the water had subsided the gas issued with a rushing noise, smelt of crude oil, and felt cold. Searching around, one or two pieces of stone bearing veins of metal were picked out of the mud and also some shells which appeared to be of marine origin. How they got there is as yet unexplained.

It is very fortunate that there was no house built or people living near the centre of the disturbance. As it was a coconut planter living half mile away has had a number of his trees uprooted or split by the violence of the explosion that must have taken place inside the earth somewhere. He was who first reported the matter. He stated he heard several sounds like cannons going off, which undoubtedly were caused by the splitting of trees".

III

B.N.B.H.
Oct 16, 1939

Origin Time
1939 Dec 21
21 hr 00 m 40.0 s
UTC

Tawau: Shortly after 5 a.m. on 22nd December, a very distinct earth tremor was felt here lasting about 1 1/2 minutes. The shock appears to have been general, being also felt in Semporna.

Epicentre
0.0 N 123.0 E

B.N.B.H.
Jan 17, 1940

Depth
150 km

Magnitude

Semporna: The earthquake shock apparently lasted for some minutes. Though

Events	Felt Effect	Intensity MM	Source
8.6 PAS	no danger seemed to have been done, considerable alarm was caused. Houses were reported to have rocked and some clocks were stopped. (The shock was not felt in Lahad Datu or in the area between Lahad Datu and Semporna).	IV-V	B.N.B.H. Jan 2, 1940
Origin Time 1940 July 21 15 hr 38 m 25.0 s UTC Epicentre 2.5 N 121.0 E Magnitude 6.25 PAS	Semporna: Two earthquake shocks were experienced here. Everyone seemed to have been awake at the time of occurrence, at 11:55 p.m.		B.N.B.H. Aug 19, 1940
1941	At Pulau Tiga, a group of three islands about half-way between Labuan and Jesselton, a mud volcano erupted and smothered seventy acres of jungle with liquid mud. It was boiling hot and the jungle trees, a hundred or more feet high, withered in the scorching flow. The eruption was heard for a distance of one hundred miles. (In May 1960 the area on Pulau Tiga affected by the liquid mud was clearly visible from the air. By May 1967, it was overgrown again with Casuarina trees and scrub).		Harrison*
1941 Feb 19	* See References Pulau Tiga Mud Volcano Eruption: The following is a description of the mud volcano eruption written by a Mr. Speedy:		

Events	Felt Effect	Intensity MM	Source
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"At midnight on the 19th February, 1941 a violent eruption which was heard 60 miles distant and covered an area of 75 acres took place on the eastern extremity of Pulau Tiga, which is an uninhabited island 275 feet in height situated on the direct steamship route between Singapore - Labuan - North Borneo in Latitude N05°43'15", Longitude E115°39'45".

The Island which embraces an area of 1700 acres is well watered and covered with a poor stand of timber.

It would appear from evidence gathered at the scene of activity that a terrific gas explosion took place, which lit up the sky for a distance of 60 miles. The shock of the explosion was in a northerly direction and fanlike in shape. The result is a mass of burnt slate coloured brittle mud, split into myriads of irregular shaped cracks, varying from 2 to 8 feet deep, 1 to 3 feet wide and 4 to 100 feet in length.

The 20 to 30 feet high trees which originally covered the area have evidently been engulfed by the discharge of liquid mud - a distance of from 50 to 200 yards from the perimeter of the eruption the jungle appears badly scorched.

Events	Felt Effect	Intensity MM	Source
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The crest of the hillock from whence the main event of gas must have been emitted appeared 9 days after the eruption burnt to a red brick colour for an area of 5000 square feet and from the centre of which 2'6" high as flame still flickered".

Another report from Beaufort give an account as follows:

Sabah State
Archives
Colonial
Record

"Considerable interest has been shown locally in the recent happenings on Pulau Tiga. Fishermen have given graphic descriptions of the eruption or explosion (whichever it was). Apparently a noise, described as like thunder was heard as far away as kampong Brunei, near Membakut and this was followed by a huge burst of fire which rose from the island and mushroomed when it had risen to a considerable height. A fisherman anchored about 4 miles away, report the heat as so intense as to cause him, even at that distance, some discomfort. He apparently up-anchored and moved away as fast as he could. We understand that there have been for many years at about the position of this explosion, two small mud volcanoes of a type which are not uncommon in the Klias Peninsula".

B.N.B.H.
Apr 1, 1941

Events	Felt Effect	Intensity MM	Source
Origin Time 1941 Nov 8 23 hr 37 m 22.0 s UTC	Tawau: A distinct earth tremor was felt at Tawau lasting for a few seconds.		B.N.B.H. Dec 17, 1941
Epicentre 0.5 N 122.0 E Magnitude 7.3 PAS			
1953 Nov 19 12 hr 05 m L.T.	Kuching: Kuching airport was shaken by two earth tremors of a few seconds duration within a short interval at 12.05 this morning. Bungalows in the areas were rocked.	III	S.T. Nov 20, 1953
1958 Oct 26 10 hr 30 m L.T.	Keningau and Sapong: The area from Keningau to Sapong suffered from an earth tremor at 10.30 a.m. It lasted for a few seconds. Items on shelves began falling, windows banged and even pictures hanging on walls were thrown down. A man, having coffee in a coffee shop, nearly had himself badly burned with boiling coffee when it began rocking and spilled the coffee, some of it on his shirt. Keningau had known earth tremors before but, according to the residents, this particular tremor was the worst so far. However, there were no casualties of any sort and damage, other than to crockery and picture frames, was negligible.	V	N.B.T. Oct 30, 1958
1964 June 28 (a) 05 hr 17 m L.T. (b) 05 hr 24 m L.T. (c) 05 hr 24.3 m	Earth tremors, described as moderately severe, were felt in the Dent Peninsula. The manager of the Kennedy Bay Timber Company reported tremors		

Events	Felt Effect	Intensity MM	Source
L.T. (d) 08 hr 30 m L.T.	felt at Bakapit, approximately 15 miles east of Lahad Datu, Sabah at 0517, 0524, 0524.3 and about 0830 on 28 June. The earlier tremors were the most severe. No unusual phenomena, such as landslides or temporary water springs, were observed in the vicinity.	IV	G.E.W.
Origin Time 1965 July 16 04 hr 48 m 33.6s UTC Epicentre 4.0 N 113.7 E Magnitude 5.0 MB Depth 65 Km	Bintulu, Miri, Lutong (Sarawak) and Seria (Brunei): A light tremor rocked several coastal towns in North Sarawak and Brunei. It was felt at the above places. It slammed doors and upset lamps, but no damage or casualties were reported.	IV	S.T. July 7, 1965
1965 July 21	Bekenu and Niah Areas: An earth tremor rocked the coastal area of Sarawak's Fourth Division. It smashed windows and slammed doors in Bekenu and Niah areas. No major damage was reported. "Malays and Punans of the area, who daily collect guano at the Niah Great Cave under Museum auspices, were frightened by what they described as "a roaring sound through the (limestone) mountain with the effect of a "sort of wave" of sound and movement" (T. Harrison, personal communication). In the cave structure, a very large stalactite broke from below the ceiling base and 30 feet in from the West Mouth, at a point where the floor-ceiling distance reaches		

Events	Felt Effect	Intensity MM	Source
	about 80 feet. The break is quite clear and reveals a hollow centre. The fallen part represents about two-thirds of the original structure, which was 8 feet long and 1-3 feet across and weights several hundred weights. It was partly fractured on impact".	V	Sar. T. July 22, 1965 & J.M.
1965 Oct 18	Mamul, Base Camp, South of Ranau: An earth tremor, lasting about three seconds, was felt here.		D.E. May 20, 1966.
1966 May 18 17 hr 25 m 50.1 s UTC	A slight tremor was felt in the Jesselton-Ranau area at 1.26 a.m. local time on 19 May 1966. The tremor was felt in Paper, Penampang, Tuaran, Kota Belud and Tambunan, in addition to Jesselton and Ranau. People were awakened by the rattling of windows, doors and crockery, by the movement of bed and by disturbed animals. Houses shook violently on their foundations but no damage was reported. The Straits Times of 20th May 1966 described the earth tremor as severe and one that shook several parts of Sabah. Many people were awakened from sleep as buildings and houses in Jesselton (Kota Kinabalu), Penampang and the surrounding areas vibrated for about a minute.	V	G.E.W. D.E. May 20, 1966 S.T. May 20, 1966 G.E.W. D.E. May 20, 1966 S.T. May 20, 1966
Epicentre 5.9 N 116.7 E			
Magnitude 5.3 MB			
Depth Normal			
	Kota Belud: A correspondent claimed that the township, about 50 miles from Kota Kinabalu	V	

Events	Felt Effect	Intensity MM	Source
	(Jesselton), was hit by two waves within 7 minutes of each other. The first wave came about 1.35 a.m. and lasted for between 10 to 15 seconds. The second was much smaller in intensity. Apart from disarranged photographs, there were no reports of damage.	IV	Sab. T. May 20, 1966
1968 Oct 10 05 hr 00 m L.T.	Tawau: Scores of sleeping inhabitants were rudely awakened at about 5 a.m. (Thursday) by a minor earth tremor. The tremor, which lasted a few seconds, rattled doors and windows and cups and saucers in the kitchens danced a merry jig. Many who felt the tremors were under the impression that they were in the midst of a nightmare.	IV	Sab. T. Oct 11, 1968
1969 Oct 29 13 hr 00 m L.T.	Tawau: An earth tremor shook this town at about 1.00 p.m., sending people dashing out doors.	III-IV	N.S.T. Oct 29, 1969
1970	Lahad Datu: (An earth tremor was said to have occurred here in 1970. No further detail is available).		
1970 July 4 to July 15	Bekenu Area, Fourth Division: Earth tremors had been recorded in the Bekenu area since July 4 on twelve consecutive days (July 4 to July 15). The tremors, lasting several seconds, were recorded at various hours of the day. A few government quarters and wooden houses were slightly damaged.	V	M. Mail July 15, 1970

Events	Felt Effect	Intensity MM	Source
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Kampong Kelulit and Kuala Sibuti: The tremors were also recorded at these two places where some glass panes in several government quarters were shattered. The foundations of some wooden houses were also affected by the tremors, one of which lasted for about 10 seconds.

V

Miri, Niah: Slight tremors were also felt in Miri and Niah (both in Fourth Division) for the last 12 days at various hours of the day.

M. Mail
July 16, 1970

1976 June 5
*19 hr 13 m 43 s
UTC

Tawau: Moderate tremors shook the town twice within an hour after 3 a.m. No damage was reported.

IV

S.T.
June 8, 1976

* As determined by Leyu
(See References)

+1976 July 26
02 hr 56 m 39.3 s
UTC

Epicentre
4.9 N 118.31 E

Magnitude
5.8, MB

(+Largest
earthquake
of the series)

A series of earth tremors shook Sabah's east coast. It first started on the 25th night of July. The first tremor was at about 10 p.m. The next tremor was felt in the early morning of the 26th. A series of earth tremors was felt on the same day. Damage was reported in Lahad Datu and Kunak. Damage to roads in the Lahad Datu district was initially estimated at nearly M\$20,000

This series of earth tremors received wide public attention locally and aroused to concern of

Events	Felt Effect	Intensity MM	Source
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the people and the government. Apart from its being widely reported by the Press, studies were carried out by several people on this earthquake swarm. Leyu* sent out questionnaires to the residents of the affected areas and Tjia* carried out a field survey after the earthquake activity.

Lahad Datu: People rushed out of their houses and many were too afraid to return for quite some time. Some houses and buildings had cracks in the walls. Several roads in the district were reported to have cracked too, causing damage initially estimated at about M\$20,000. A four-storey police complex nearing completion was also reported to have suffered severe structural damage. There was, however, no loss of life.

A police officer reported that the earthquake motion lasted for about 8 seconds and was felt by many people. Trees and bushes were shaken slightly. Some small objects were shifted or overturned. In some places the ground, walls, windows and plaster cracked; some dishes, window and furniture were broken. Damage was said to be considerable. Some animals were frightened. A rumbling sound, like a passing truck, lasting for

Events	Felt Effect	Intensity MM	Source
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about 4 seconds, was heard.

A medical doctor attached to the Lahad Datu District Hospital reported that the motion was rapid, lasting for about 15 seconds and was felt by all medical personnel and patients. Windows, doors and dishes rattled. Some plaster was cracked. From a small hill near to town, thick clayey liquid burst out with considerable force and spread over the hill within a radius of 30 feet.

VII

Leyu*

The following were observed at Lahad Datu by Tjia:

The two five-storey police complexes, which were almost 80 per cent completed, were said to have suffered severe structural damage. H.D. Tjia (1978), who investigated the earthquake damage in early March 1977, noted that in the northern building (repairs were almost completed in the southern building), earthquake damage consisted of systematic fractures on the cement walls, the cement floors and on some concrete pillars. A number of brick and mortar walls had collapsed, wholly or partially. He could not ascertain if any tilting of the building had occurred.

Damage to the one-storey

Events	Felt Effect	Intensity MM	Source
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communications building, next to the five-storey buildings, was slight. Fractures were common on the cement apron around the building. The western wall of this building also displayed irregular cracks.

A wooden house, on 2.5 metres high stilts, had its stilts slanted towards W225°E at twelve degrees from the vertical. In spite of the slant, however, the house floor remained more or less horizontal. Scars were also left on the hill slopes to the north of the house, due to recent mass movements. Several coconut trees were uprooted, while the undulating, barren ground surface indicated continued creep. A dried mud flow with a front 50 to 75 metres wide was present.

Effect on the sawmill complex that was built on reclaimed land at the coast: The brick-and-mortar one-storey office building of the sawmill had a concrete apron all around; fractures were common in the apron where it adjoined supporting columns. The north and west sides of the building indicated relative displacements ranging between 0.4 and 2.5 cm between the apron and the building proper. Several steel pillars of a shed had also been disturbed by the

Events	Felt Effect	Intensity MM	Source
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earthquake. The roof shifted towards west in relation to the floor and caused a one-degree tilt of the steel pillars. The cement floor also indicated settling, as much as 3 cm with respect to the pillars.

Effect on the new business centre: Fractures were found on the various walls of the three rows of three-storey buildings built of cement, brick and mortar and concrete pillars.

Effect on wooden houses on stilts: The stilts had been tilted (about three to five degrees) from the vertical.

Near the west end of the runway of Lahad Datu's airfield, a new mud-cone (mud volcano) erupted during the main earthquake shocks. Immediately after the main shocks, mud spouted up to a height of about three metres, according to the local inhabitants.

According to local inhabitants, a peculiar rumbling noise seemed to accompany the earthquake. In Lahad Datu town, suspended house-objects swayed towards north and south.

Tjia*

Kunak: Five houses sank partially into the ground and two persons were injured. Two houses in nearby Kampong Pengkalan

Events	Felt Effect	Intensity MM	Source
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were damaged.

VII

Leyu

An officer from the Kunak District Office, Sabah, reported that everyone in the community was frightened. Walls of a few buildings were cracked. Hanging objects swung. Trees and bushes shook for several minutes. Small objects were shifted or overturned. Books, pictures and plaster fell. Dishes, windows and furniture were broken. Damage was described as considerable in buildings built of native materials and wood. He heard some sound like the rolling of a galvanized iron tank. A few persons lost their balance and fell.

Leyu

Another officer from the Agriculture Department, Kunak, reported that the motion was rapid, lasting for about 5 seconds. However, he was not sure of the direction. Trees and bushes were shaken moderately. Domestic animals ran in all directions. A rolling sound, like thunder, was also heard.

Leyu

The following were observed at Kunak by Tjia (1978):

Effect on Kunak Wharf area: The landing at the wharf consisted of two concrete slabs, each measuring 10 m x 7 m and bordered on three sides by a 20 cm high and 50 cm

Events	Felt Effect	Intensity MM	Source
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thick cement wall. On the sea side, the landing was supported by two large pillars. The earthquake caused fractures in the concrete slabs in the low cement walls and a hinge fault between the north wall and the floor.

Towards NW, at a distance of 30 to 60 metres from the landing, five wooden houses, standing on long stilts in the sea, had partially collapsed on account of the earthquake (two people were injured according to S.T. report of 28 July 1976). Another houses, built on level ground at the waters' edge, several tens of metres west of the landing, slanted northwards at six degrees from the vertical.

Effect of earthquake on land movement: Slumps involving 5 metres, or thinner terrace deposits and underlying layer sediments, were seen at two localities. The slumps were said to occur after the earthquake. Cracks have appeared in the roads. Well water was suspected to have been polluted.

Tjia

Tawau: Several tremors were felt in Tawau, beginning at 10.30 a.m. 26 July 1976. The strongest one occurred at 11 a.m. Several commercial banks reported their walls had cracked. There were com-

Events	Felt Effect	Intensity MM	Source
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plaints of water pollution, alleged to have been caused by the tremors.

Some shops reported that goods were flung off shelves.

V

K.S.T.
July 18, 1976

An official of the Chartered Bank reported that the motion was slow, lasting for about 10 seconds, and was felt by all staff and customers. Hanging objects swung and slight cracks appeared in walls.

Leyu

Another resident, a medical doctor in the General Hospital, reported that the motion was slow, lasting for about 6 seconds and was felt by all. It caused concern and fright to many people. There was rattling of windows, doors and dishes. Some walls in the hospital building were cracked. Ceiling fans swung. Shifting of small objects was minimal. Some people felt giddy.

Leyu

The staff from the Hong Kong and Shanghai Bank, Tawau, reported that the motion was slow, lasting for 45 to 50 seconds. It frightened most of the people in the community. There was slight rattling of windows and doors. Slight cracking of walls was noted. Trees were shaken slightly. The sound (possibly due to rattling of windows and doors) lasted for 10 to 15 seconds.

Leyu

Events	Felt Effect	Intensity MM	Source
<p>Sandakan: A slight tremor was felt here at about 11 a.m. Office workers in a 10-storey building rushed out. The walls of a commercial bank building were said to have cracked.</p>		III-IV	<p>N.S.T. July 27, 1976</p>
<p>An Agricultural Officer reported that the motion was slow, lasting for a few seconds and was felt by several people and frightened many in the community. He described the shock as not serious. Another officer, from the Forestry Department, described the motion as slow, moving from north to south, lasting only for about 2 seconds. Many in the office were frightened. Cracking of walls was described as slight. A sound like a gust of wind lasting for 2 seconds was heard.</p>			Leyu
<p>Another doctor, attached to the Duchess of Kent Hospital, Sandakan, reported that he did not feel anything and that he was about one mile from the reported tremor area.</p>			Leyu
<p>Semporna: A slight tremor was also felt here. No damage was reported.</p>		III	<p>N.S.T. July 27, 1976</p>
<p>An officer from the Balai Polis, Semporna reported that the motion was slow, lasting for about 5 seconds and was felt by many people.</p>			Leyu
* See Reference			

Events	Felt Effect	Intensity MM	Source
<p>Origin Time 1981 Dec 25 00 hr 28 m 15.7 s UTC</p> <p>Epicentre 4.76N 118.48E</p> <p>Magnitude 5.4 MB</p> <p>Depth 39 Km</p>	<p>Tawau: The town was jolted by an earth tremor for about 30 seconds at about 8.30 a.m. No damage was done. Many people rushed out of their places of work for safety. A motorist, who was sitting inside his parked car, felt it shaking. An unoccupied car parked beside him was seen moving forward a little. Several people were heard screaming.</p>	IV	D.E. Dec 29, 1981
<p>Origin Time 1984 Mar 05 03 hr 33 m 51.2 s UTC</p> <p>Epicentre 8.14N 123.77E</p> <p>Magnitude 6.7 MB</p> <p>Depth 651 D</p>	<p>Kota Kinabalu: A very slight tremor was felt by government officers working in a 27-storey (Yayasan Sabah) building in Likas. It was also felt by several residents of the town, especially those working in tall buildings.</p> <p>Damage to the Yayasan Sabah building was slight. Ceiling tiles on one floor shifted slightly, covering the floor below with plaster and minor cracks appeared in wall joints on the 10th floor (doubtful). (A woman fainted in the confusion).</p> <p>Staff on upper floors who stayed at their desks during the shock at Wisma Sabah also felt the tremor.</p>	I-II	B.B. Mar 10, 1984
<p>Origin Time 1984 Mar 14 00 hr 39 m 18.5 s UTC</p> <p>Epicentre 5.22N 118.45E</p>	<p>Tawau: The tremor was felt for a few seconds by residents at 8.29 a.m. The tremor caused window panes to rattle, ceiling lights to swing and tables and chairs to move.</p>		

Events	Felt Effect	Intensity MM	Source
Magnitude 5.6 MB	Sandakan: The same effect as at Tawau was felt here.		
Focal Depth 52 Km	Lahad Datu: The tremor was felt here for a few seconds.	IV	
	Sembulan: About 40 staff on the fourth and fifth floors of a building felt the tremor for about seven seconds and rushed downstairs. They complained of headache.	III	D.E. Mar 15, 1984
	According to Geological Survey Sabah, the tremor was felt also at Kota Kinabalu and Tambunan.		
	* From earthquake list provided by the International Seismological Centre.		
	Editor Note: It appears that the intensity assessments in most of the preceding section are about one degree too low. For example, clocks stopping is explicitly stated as being MM V whereas the assessment for the earthquake of 1936 Sep 19.		
	Kuala Lumpur was assessed as MM IV even though there are at least two data indicating higher ones.		
	These assessments have been let stand because the reader is at liberty to make his own in as much as all the data is available.		

PART B
EARTHQUAKE INTENSITY ANALYSIS

PART B EARTHQUAKE INTENSITY ANALYSIS

Introduction

In preparing this report, special effort has been made to avoid any unnecessary alterations to the original descriptions as given by the various sources. In many instances, the original versions are actually presented. This approach is felt necessary, as the determination of intensity based on felt reports is subjective and the values assigned by different investigators are likely to differ. Any alteration or rephrasing of the text may cause some distortion.

In this report, the Modified Mercalli Intensity Scale is used throughout, a copy of which is given as Appendix IV. Whenever the information is sufficient, the intensity at a place is evaluated. As the felt intensity varies from location to location within a small distance of kilometres, the maximum intensity observed at a town or place is always assigned. For example, during the May 17, 1892 earthquake, while people in several locations in Singapore were sent rushing out of their houses in panic, people in certain parts of the town did not feel anything at all! An intensity of IV is assigned to the Island in this case.

Attempts to draw isoseismal maps for the earlier earthquakes, especially those before 1900, are hampered by the lack of good coverage of felt reports. This is because populations were then mainly concentrated along coastal areas, while inland areas were still basically unpopulated. For example, the 1851 and 1892 earthquakes were two of the most severe ones felt in Peninsular Malaysia, but felt reports were available only for Penang, Malacca and Singapore. Nevertheless, earthquakes that occurred in the early twentieth century and thereafter were fairly well reported. Several isoseismal maps of the larger earthquakes can be drawn. They are presented as Figures 1 to 6.

With the earthquake information gathered, the maximum intensity ever recorded at any place during the period covered is determined. Isoseismal maps of maximum observed intensity for Peninsular Malaysia (1805-1983) and for Sabah and Sarawak (1884-1983) are then drawn. They are presented as Figures 7 and 8.

It must be mentioned that the isoseismal maps drawn are approximate. This is deemed unavoidable as felt reports were scarce over inland undeveloped areas. Even in heavily populated areas, only careful field investigations can ensure that the isoseismals drawn are accurate. Nevertheless, these maps are able to give an idea of the earthquake intensities' distributions.

Maximum Intensity-Magnitude Relation

Sabah and the eastern portion of Sarawak are the only areas in Malaysia where a number of local earthquakes have occurred in

the past. However, as the area is sparsely populated, only the maximum intensities of less than a handful of these located earthquake are known. These few sets of values are given below:

	Magnitude (Mb)	Max. Intensity (MM Scale)
1.	5.8	VII
2.	5.3	V
3.	5.0	IV

Intensity Attenuation Rate

The Lahad Datu (Sabah) earthquake of July 26, 1976, 02 hr 56 m 39.3 s UTC, of body-wave magnitude 5.8 is the only local earthquake in Malaysia that has been well-studied. An isoseismal map of this earthquake has been drawn (Figure 6). As the isoseismals are elongated, it means the attenuation rate is not uniform for all directions. Several sets of intensity values with respect to epicentral distances are taken. An attempt to draw a single composite line of best fit using the linear regression method shows poor correlation. Instead, two lines giving the maximum and minimum attenuation rates are drawn (see Figure 9).

For other local earthquake, reliable isoseismal cannot be drawn and hence their intensity attenuation rates cannot be evaluated.

For Peninsular Malaysia, though several isoseismal maps have been drawn, the epicentres of these earthquakes are, however, several hundreds of kilometres away. Intensity attenuation rates at such great epicentral distances will not be of much interest and are therefore not evaluated.

Conclusion

The Macroseismic Study carried out has revealed the following facts:

- (a) That Peninsular Malaysia has experienced a maximum intensity of V on the Modified Mercalli Scale. The tremors originated from earthquakes over the earthquake belt along Sumatra Island and were due to mainly to the effect of surface waves.
- (b) That Sabah has experienced a maximum intensity of VII on the MM Scale, due to earthquakes of local origin. Damage to property and even human injuries as a result of earthquakes have occurred in the past.
- (c) That Sarawak has experienced a maximum intensity of V, due also to earthquakes of local origin. This is confined to the eastern portion of Sarawak, where damage to window panels etc. has occurred.

Discussion

It may be noted that, though the earthquake epicentres are hundreds of kilometres away, the isoseismal lines over the west coastal areas of Peninsular Malaysia (as found in the isoseismal maps, figures 1 to 4) are rather concentrated. This could perhaps be due to the alluvial nature of the soil in these areas.

Explanation of Abbreviations Used

A.H.S.	Annedotal History of Singapore*
A.R.G.S.	Annual Report Geological Survey
B.B.	Borneo Bulletin
B.N.B.H.	British North Borneo Herald
C.F.R.	Charles F. Richter*
D.E.	Daily Express
F.P.	Free Press
G.E.W.	G.E. Wilford*
H.N.R.	H.N. Ridley*
Hr m s	Hour, minute, second
J.M.	John Milne*
K.S.T.	Kinabalu Sabah Times
L.T.	Local Time
Mb	Body-wave Magnitude
M. Mail	Malay Mail
M.M. Scale	Modified Mercalli Scale+
N.B.T.	North Borneo Times
N.S.T.	New Straits Times
N. Sun. T.	New Sunday Times
PAS	California Institute of Technology
P.G.	Penang Gazette
P.G.M.A.	Penang Guardian and Mercantile Advertizer
P.W.I.G.	Prince of Wales Island Gazette
S.C.	Singapore Chronicle
S.C.J.P.	Sin Chew Jit Poh
S.E.	Straits Echo
S.F.P.	Singapore Free Press
S.T.	Straits Times
Sab. T.	Sabah Times
Sar. G.	Sarawak Gazette
Sar. T.	Sarawak Tribune
Sun. T.	Sunday Times
T. Star	The Star
UTC	Coordinated Universal Time
Y.K.P.	Yik Khuan Poh

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+ See Appendix IV

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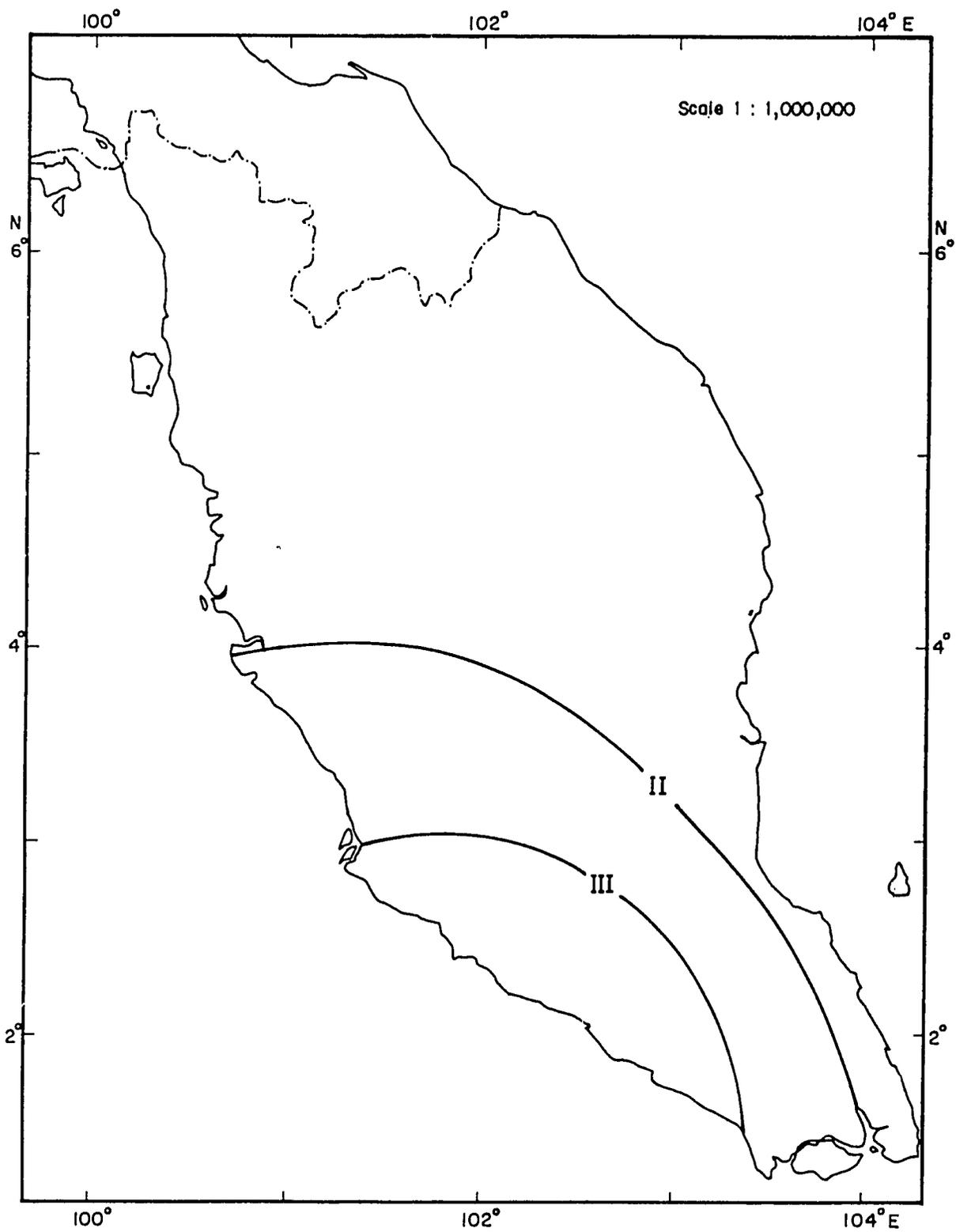


Fig. 1 Isoseismal Map of the Earthquake of Jan. 31, 1922 09 hr. 50m L.T.

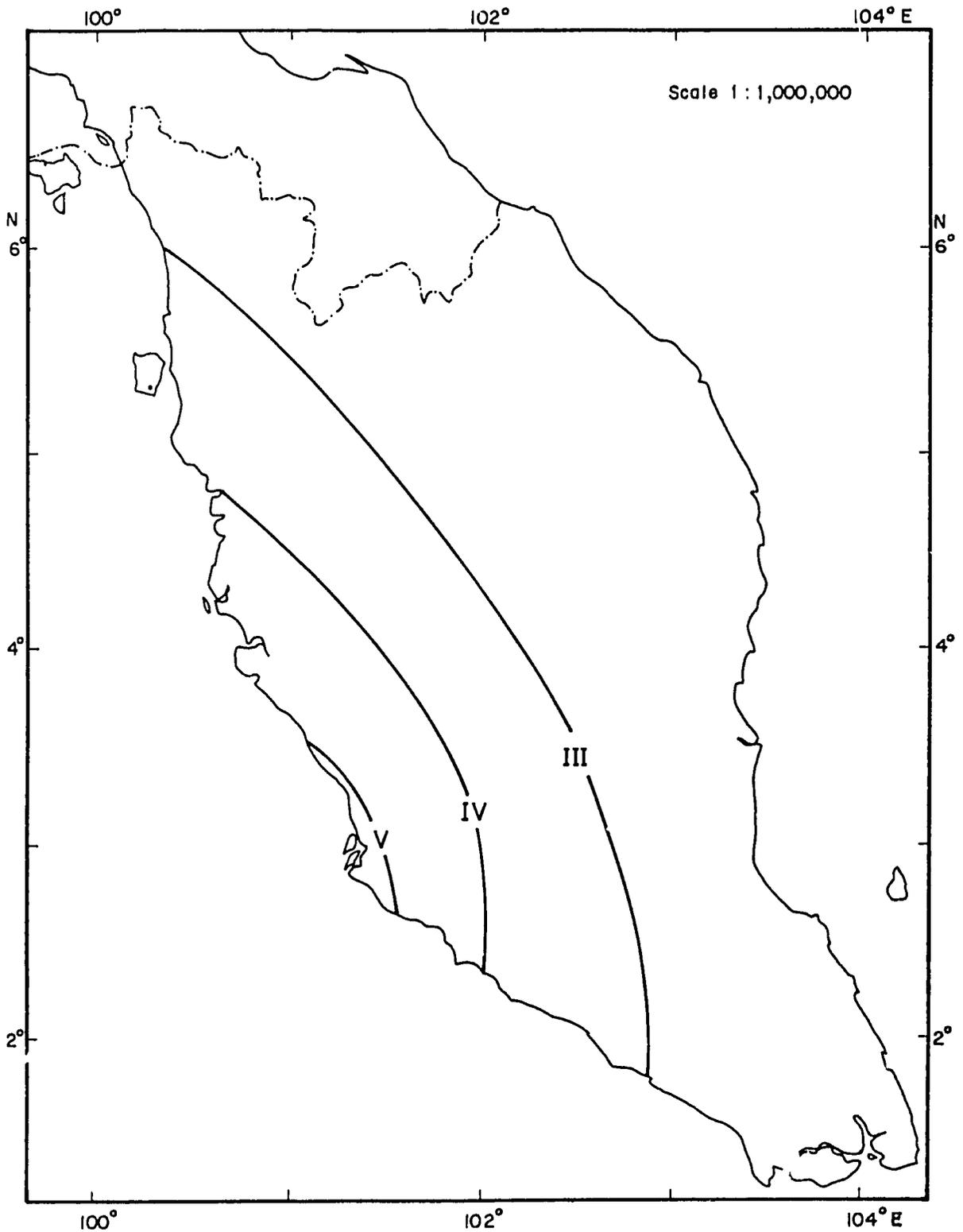


Fig. 2 Iseisimal Map of the Earthquake of Sept. 19 , 1936
 Epicentre : 3.75 N 97.5 E
 Magnitude 7.2 PAS

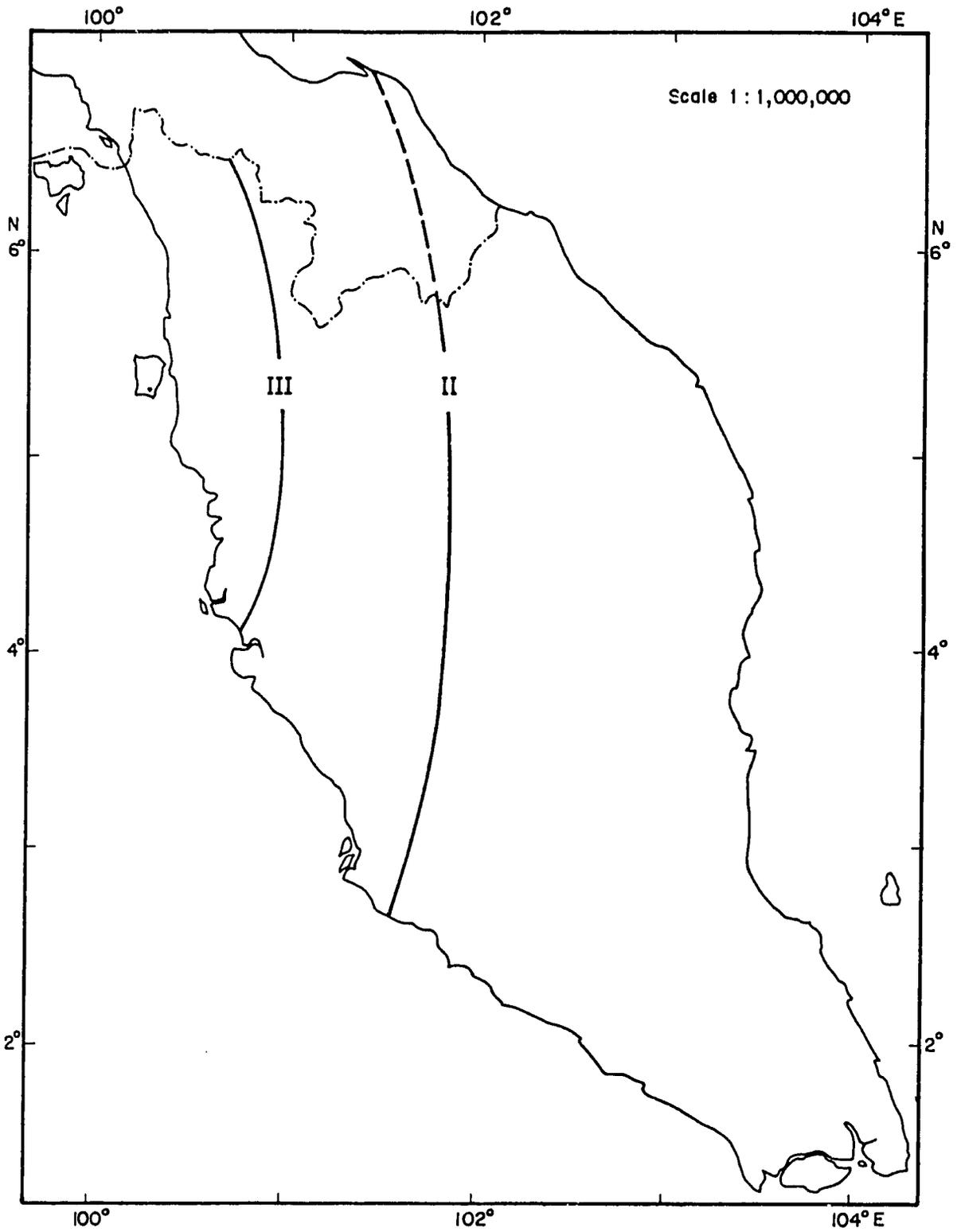


Fig. 3 Iseismal Map of the Earthquake of April 12 , 1967
Epicentre : 5.16 N 96.3 E
Magnitude: 6.1 MB

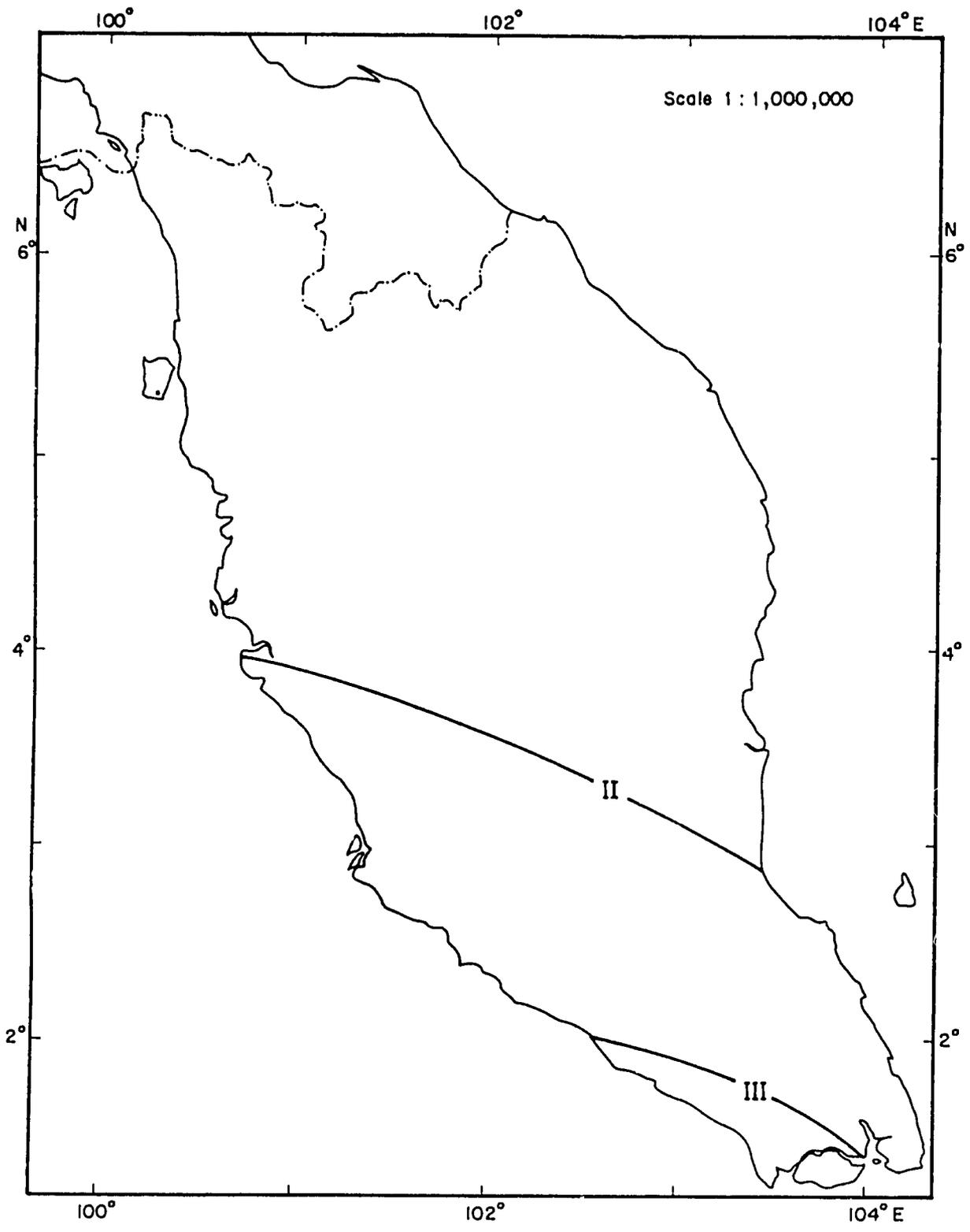


Fig. 4 Isoseismal Map of the Earthquake of Feb. 04 , 1971
 Epicentre : 0.64 N 98.83 E
 Magnitude : 6.3 MB

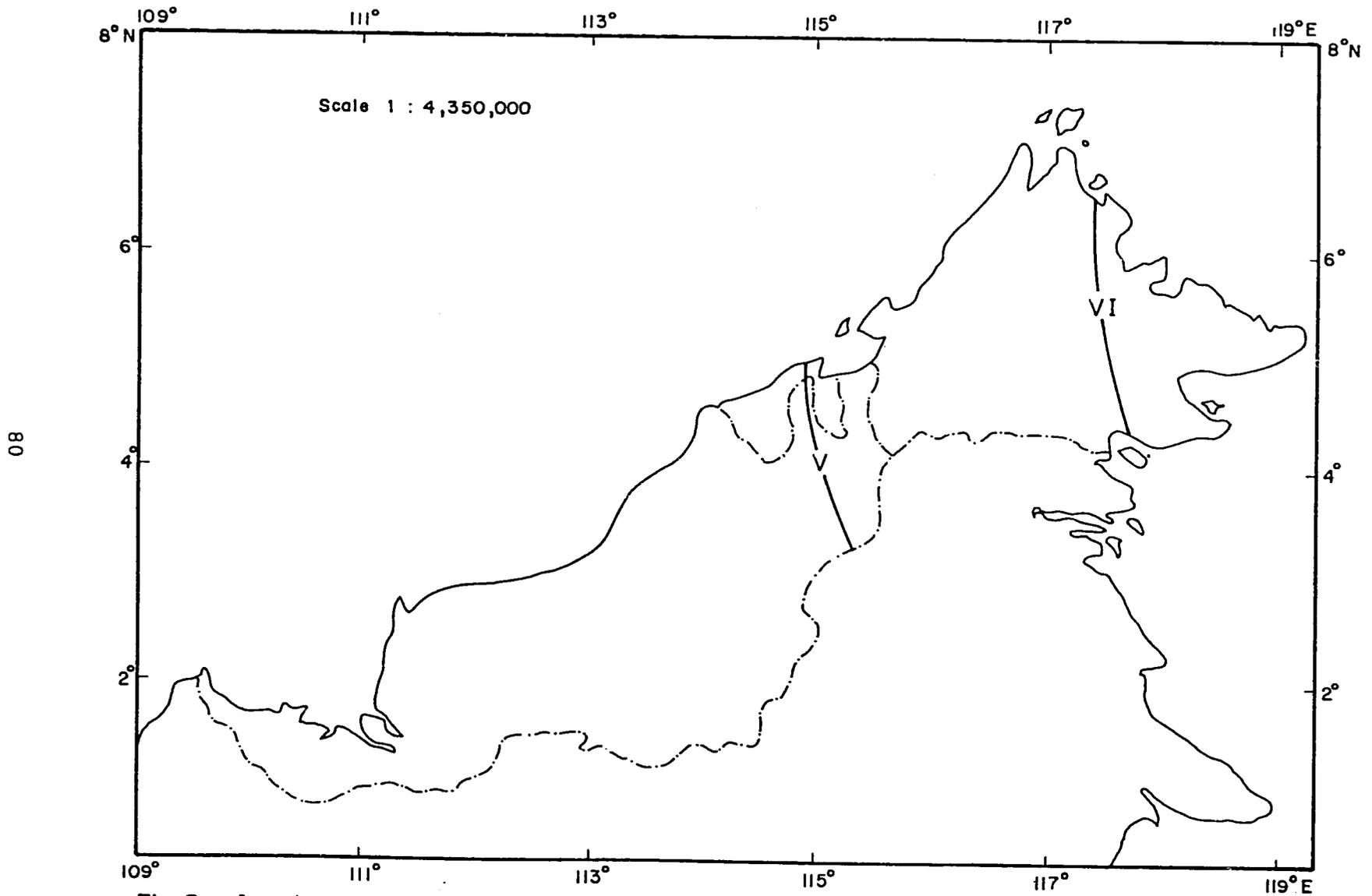


Fig. 5 Isoseismal Map of the Earthquake of Sept. 21, 1897 Epicentre : 6.0N 122.0E Magnitude : 8.7 CFR

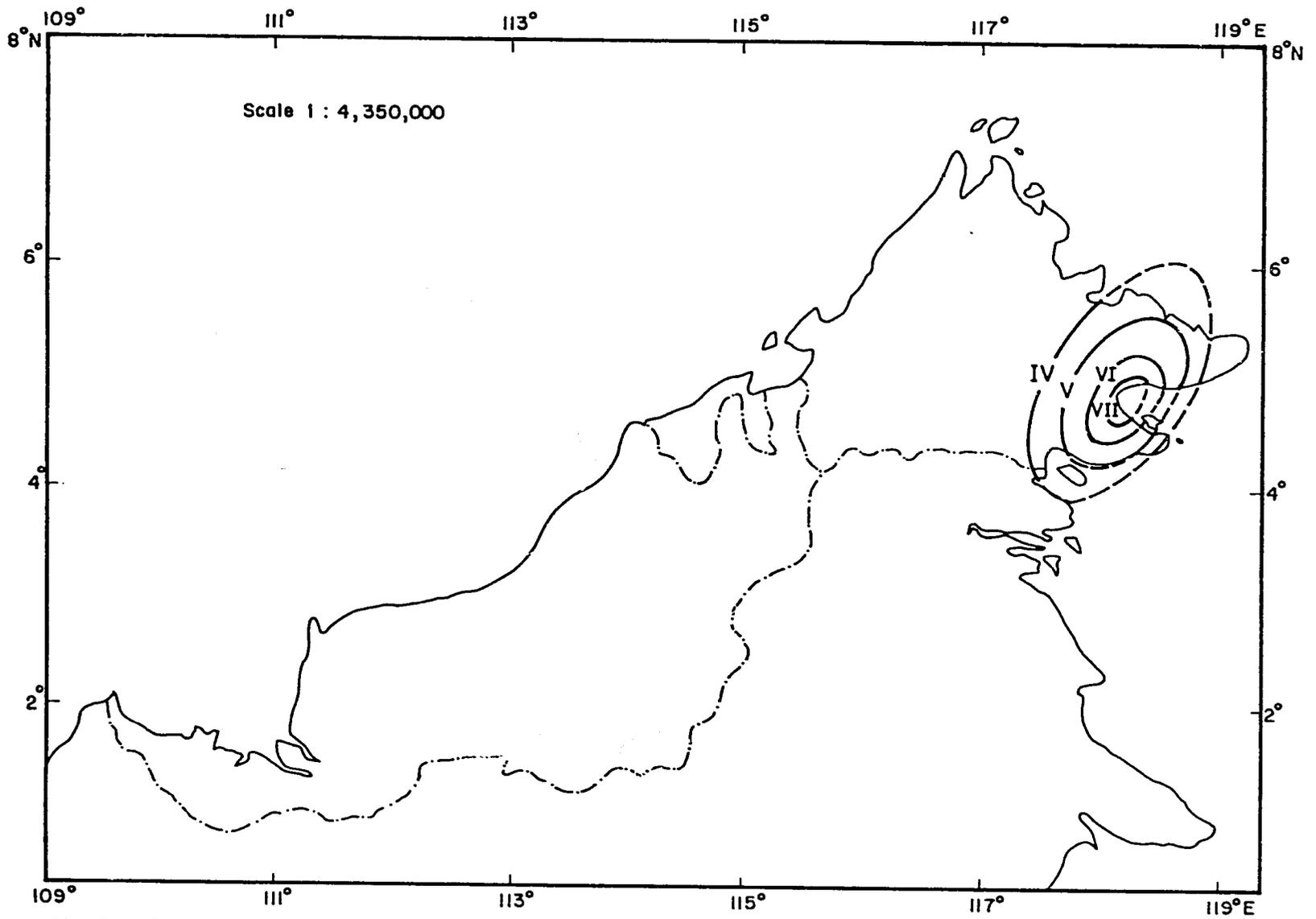


Fig 6 Isoseismal Map of the Earthquake of July 26, 1976 Epicentre: 4.90 N 118.3 E Magnitude: 5.8 MB

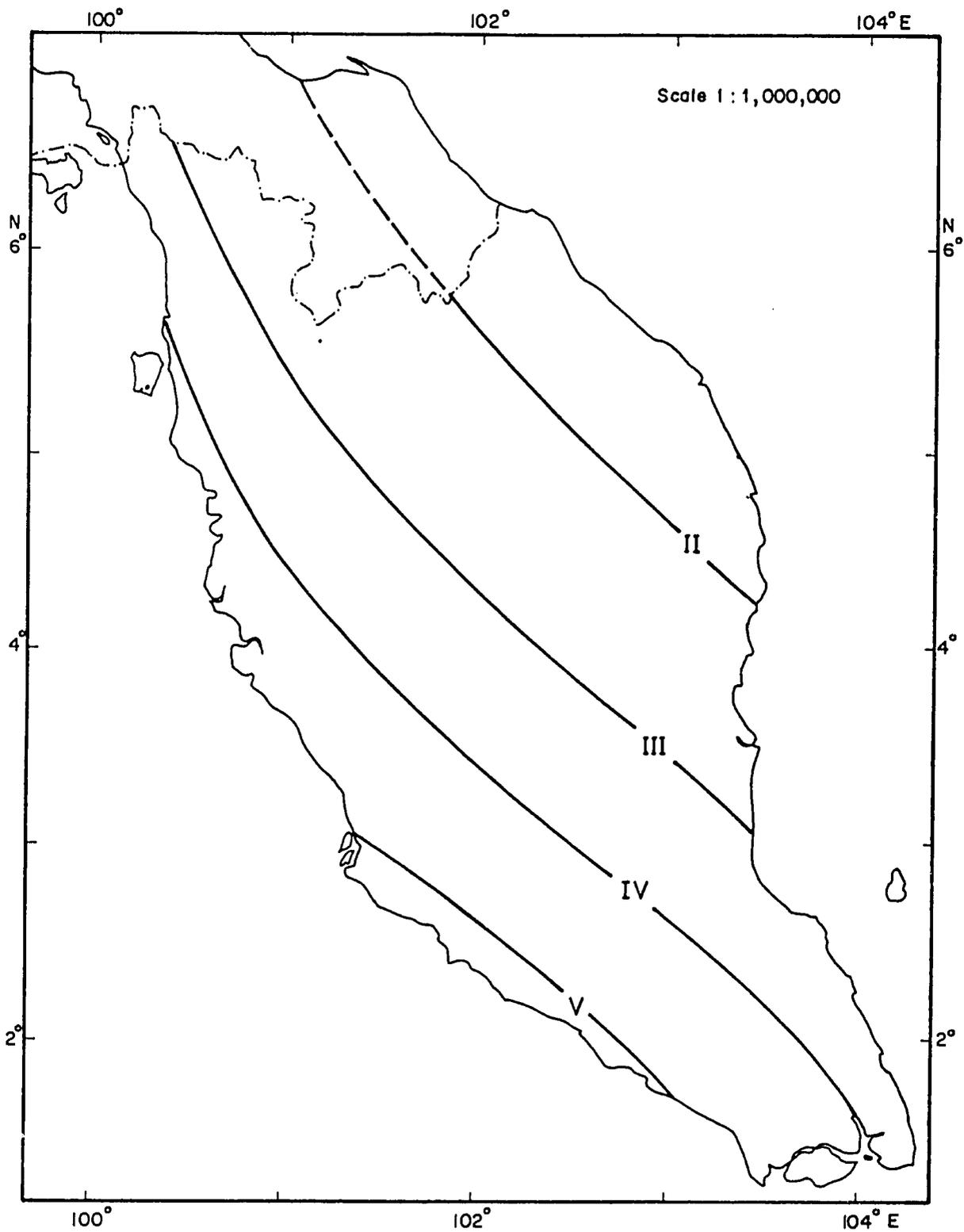


Fig. 7 Maximum Observed Earthquake Intensity Peninsular Malaysia (1805-1983)

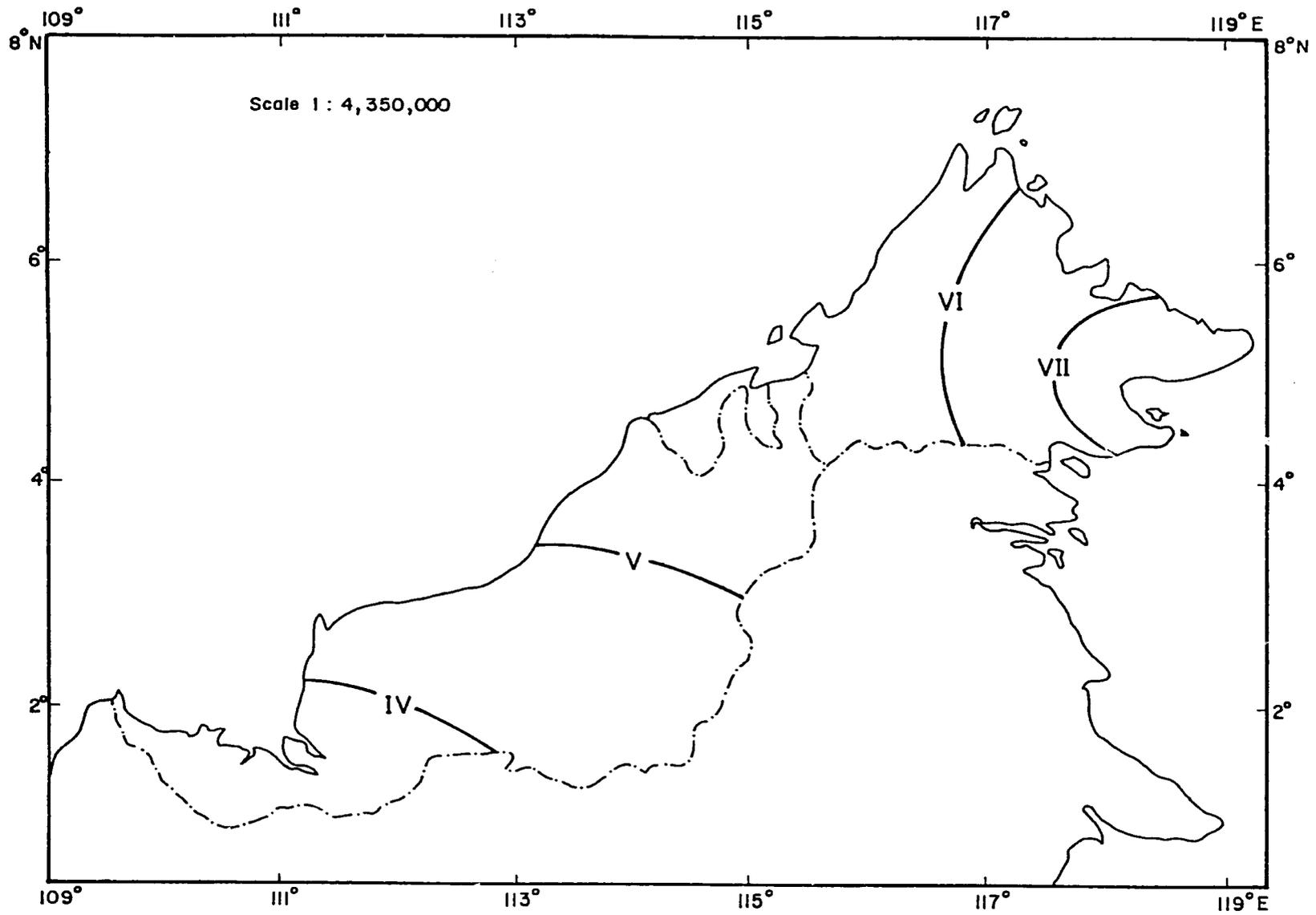


Fig. 8 Maximum Observed Earthquake Intensity Sabah and Sarawak (1884 - 1983)

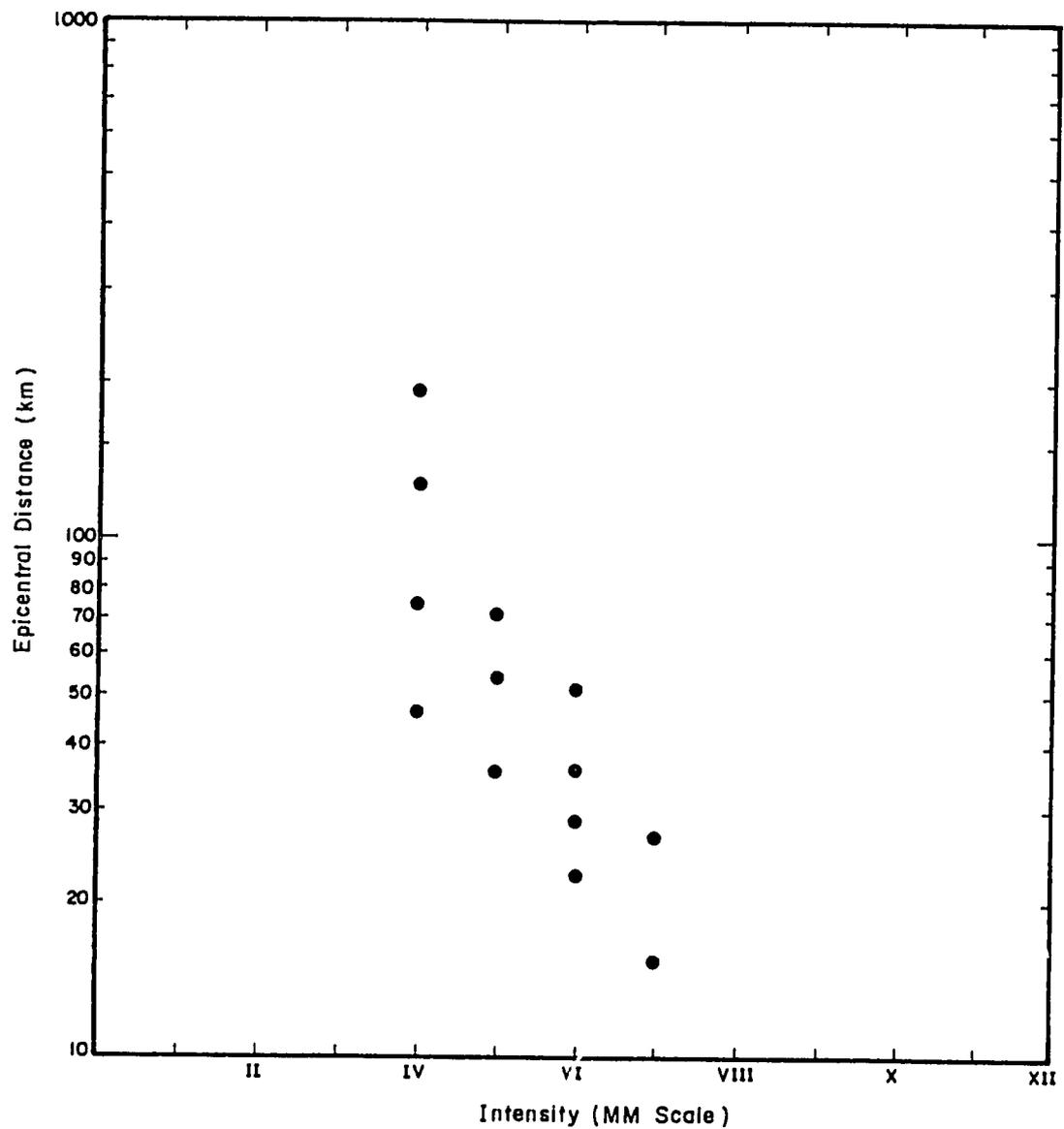


Fig. 9 Intensity Attenuation Rates of the Earthquake of July 26, 1976
 Magnitude : 5.8 Mb

PART C
SEISMOTECTONIC SETTING OF MALAYSIA

PART C SEISMOTECTONIC SETTING OF MALAYSIA

Introduction

Apart from the State of Sabah, Malaysia lies along the eastern and western fringes of the Sunda Shelf. Although this shelf is tectonically stable, it nevertheless is bordered by several active regions the seismicity of which is intense. The effects of large earthquakes in these active regions could extend into the area and are expressed as maximum observed intensity isoseismal lines.

General Geology

The geological ages of rock formations become younger from west to east. A well-represented sequence of Palaeozoic and Mesozoic rocks ranging in age from Cambrian to Cretaceous is found in Peninsular Malaysia. Two sedimentation regimes are recognized based on their different periods of initial sedimentation, a western regime where a conformable Cambrian - Permian succession is evident, and an eastern regime where Carboniferous - Permian strata crop out in the central and eastern parts of the peninsula. On the basis of their stratigraphic record and characteristics, the western regime is subdivided into the north-western zone and the western zone, and the eastern regime into the central zone and eastern zone (Foo, 1983).

The earliest sedimentation began during Late Cambrian in the western regime and sedimentation was more or less continuous until the Permian in the northern part, while in the southern part an unconformity has been reported separating the Upper Palaeozoic from the Lower Palaeozoic. In the eastern regime, shallow marine sedimentation commenced in Early Carboniferous and probably continued uninterrupted until Late Permian. However, the central zone of the regime differed from the eastern zone in the accumulation of abundant volcanoclastics in the later stages of sedimentation while the eastern zone remained tectonically more stable. Sedimentation continued in the tectonically unstable central zone where a thick sequence of continental cover rocks extend into the Late Mesozoic.

The eastern zone appears to extend over part of the Sunda Shelf across to the western portion of the Sarawak State on the island of Borneo. This block includes the Natuna and Anambas islands of Indonesia. Marine sedimentation commenced in Late Carboniferous and probably continued with minor interruptions until the Lower Tertiary when a thick sequence of continental cover rocks was also laid down.

The so-called 'Northwest Borneo Geosyncline' covers a large area extending from the central portion of Sarawak northward to the western portion of the State of Sabah. The oldest rocks known are of Cretaceous age and occur in the southern margin along the

'Lupar line', an old subduction zone. Sedimentation is continuous through to the Quaternary with a thick succession of flysch-type deposits making up the lower part of the sequence. Only one major break in the sedimentary sequence occurs in the Upper Eocene which separates the more deformed from the less deformed rocks. The younger rocks in the sequence also form some isolated basins.

With several regional tectonic trends converging on the northern part of Borneo Island, Sabah has a more complex geological setting. The northeast trending crescent of the 'Northwest Borneo Geosyncline' appears to bend east where the southern end of the Palawan-Balabac island arc stops near the northern edge of Sabah, while to the east the geology is linked to the Sulu volcanic arc. The crystalline basement consisting of gneiss, chert, spilite and ophiolite appears to be associated with these arc systems. The oldest sedimentary rocks are Early Cretaceous limestones deposited on the emerging basement in eastern Sabah. By Late Cretaceous, thick clastic and calcareous sediments and volcanic rocks were widely deposited up to Eocene time.

A major tectonic event in the Late Miocene probably initiated the formation of the two volcanic arcs, resulting in the accumulation of thick sequences of slump deposits and pyroclastics in eastern Sabah. This led to volcanic events in the east and plutonic intrusions to the west during the Pliocene.

Tectonic Setting

The tectonic evolution of Malaysia is closely reflected by the stratigraphic successions as depicted above. In the Peninsula it consists of a tripartite evolution into the western zone which is similar to the western regime, the central zone and eastern zone making up the eastern regime.

The western regime probably originated as a small fragment of Gondwanaland which drifted eastwards in the Upper Palaeozoic to meet another piece of landmass from Cathaysia. The collision generated intense volcanism along the central zone, culminating in widespread development of granitoids in the Late Triassic.

Good fusion occurred along the contact between the eastern zone and the central zone but movements were reactivated along part of this boundary as the Lebir and Lepar faults. Thus the stresses were mainly relieved further to the west along the boundary between the eastern and western regimes, known as the 'Bentong Line'. This line, which also contains the only recognizable serpentinite belt in the Peninsula, could have been active through the Mesozoic to the Tertiary. It truncated and post-dated all the large pervasive NW-SE trending faults. However, due to the lack of seismic activity in this region, the 'Bentong Line' appears to be inactive within recent times.

Many large northwest-southwest trending faults truncate the

Peninsula. Some of these faults appear to postdate a number of small Tertiary sedimentary basins on land. This feature suggests that some of these faults were active in the Late Tertiary.

The youngest faults appear to be a cluster of east-west trending structures in a sedimentary basin just offshore Kuantan. This structure can be traced onshore and probably was the conduit through which the Kuantan basalt was extruded. This basalt was dated at approximately one million years old. Similar fracture systems probably also occur within the Sunda Shelf and on the island of Borneo, where plateau basalts in the Upper Rajang and Tinjar areas in Central Sarawak, of Pliocene to Pleistocene age, are probably related.

The major structure in West Sarawak is the 'Lupar line', an old plate boundary upon which the 'Northwest Borneo Geosyncline' was formed. The rock strata of this geosyncline are partly truncated by a northwest trending fracture system in Central Sarawak. This fault is in line with a large offshore fault south of Miri, where a shallow magnitude 5 earthquake was located in 1965. This fault system is probably active.

In western Sabah, a swarm of northeast to north-northeast trending active faults is associated with some earthquake epicentres. To the east the major structures are east-west and are probably associated with an earthquake swarm occurring in 1976, with the largest event measuring magnitude 5.8.

Seismotectonic Setting

The relation of the area under consideration to the principal seismotectonic units of the South-East Asian region is shown in Figure 10. It lies in the western part of a seismically stable region that includes Peninsular Malaysia, much of Indo-China, the island of Kalimantan (Borneo), and the South China Sea. Although the whole of this has been referred to as the Sunda Shelf by some seismologists, it is not a single structural unit. Most of it is known to have, or may reasonably be inferred to have, a crust of continental thickness. This includes the shallow epicontinental sea to which the term 'Sunda Shelf' should more appropriately be limited. The crust beneath the deep water east of Indo-China, however, is oceanic. Although the structural contrast is not extreme, some earthquakes would be expected at the junctions. None of them appears to have exceeded magnitude 5 and, since it seems to be appropriate to treat this system as a fracture zone within a stable block, it would be surprising if a shock in the area were to reach magnitude 7.

The western, southern and eastern boundaries of this stable block are marked by vigorously active asymmetric arcuate systems, the earthquakes of which can produce appreciable effects within the region under consideration. They exhibit activity of the type and vigour familiar in northern Japan, the Aleutians, and on the Pacific coast of South America.

It is pertinent to note that, in Malaysia, only Sabah experiences earthquakes of local origin. Outside Sabah only one epicentre was recorded in Central Sarawak. All the earthquakes are of medium to low magnitude.

Seismic Effects

The effects of large earthquakes in the active regions surrounding the Sunda Shelf could extend and have extended to Peninsular Malaysia, Sarawak and Sabah.

In the Peninsula the foci of all these earthquakes were located mainly to the west in Sumatra or northwest in the Andaman Islands. In all these tremors, no casualties or damage to houses were recorded. The most severe cases reported objects falling from shelves.

Seismic effects, as experienced in West Sarawak, are almost identical to those of the Peninsula. However, in Central-North Sarawak and Sabah local earthquakes gave rise to stronger felt intensities. The larger earthquakes resulted in minor cracks in masonry walls and narrow fissures in the ground, while the 1976 earthquake (5.8 MB) in Eastern Sabah resulted in partial damage to a number of buildings and roads. The eruptions of mud volcanoes were associated with the more severe earthquake tremors.

The felt intensities of large earthquakes located in the Straits of Macassar and the Celebes Sea are higher in Sabah, but they are not expected to be more damaging than those associated with the local earthquakes.

The Malaysian Meteorological Service initiated a research programme to locate historical accounts of earthquakes felt within Malaysian for the period covering 1805 to 1983 for the Peninsula and 1884 to 1983 for Sabah and Sarawak. From such accounts the earthquake intensity on the Modified Mercalli scale for each event was estimated and plotted on maps. The data were sufficient to produce isoseismal maps, Figure 11 and Figure 12, for Peninsular Malaysia and Sabah and Sarawak respectively.

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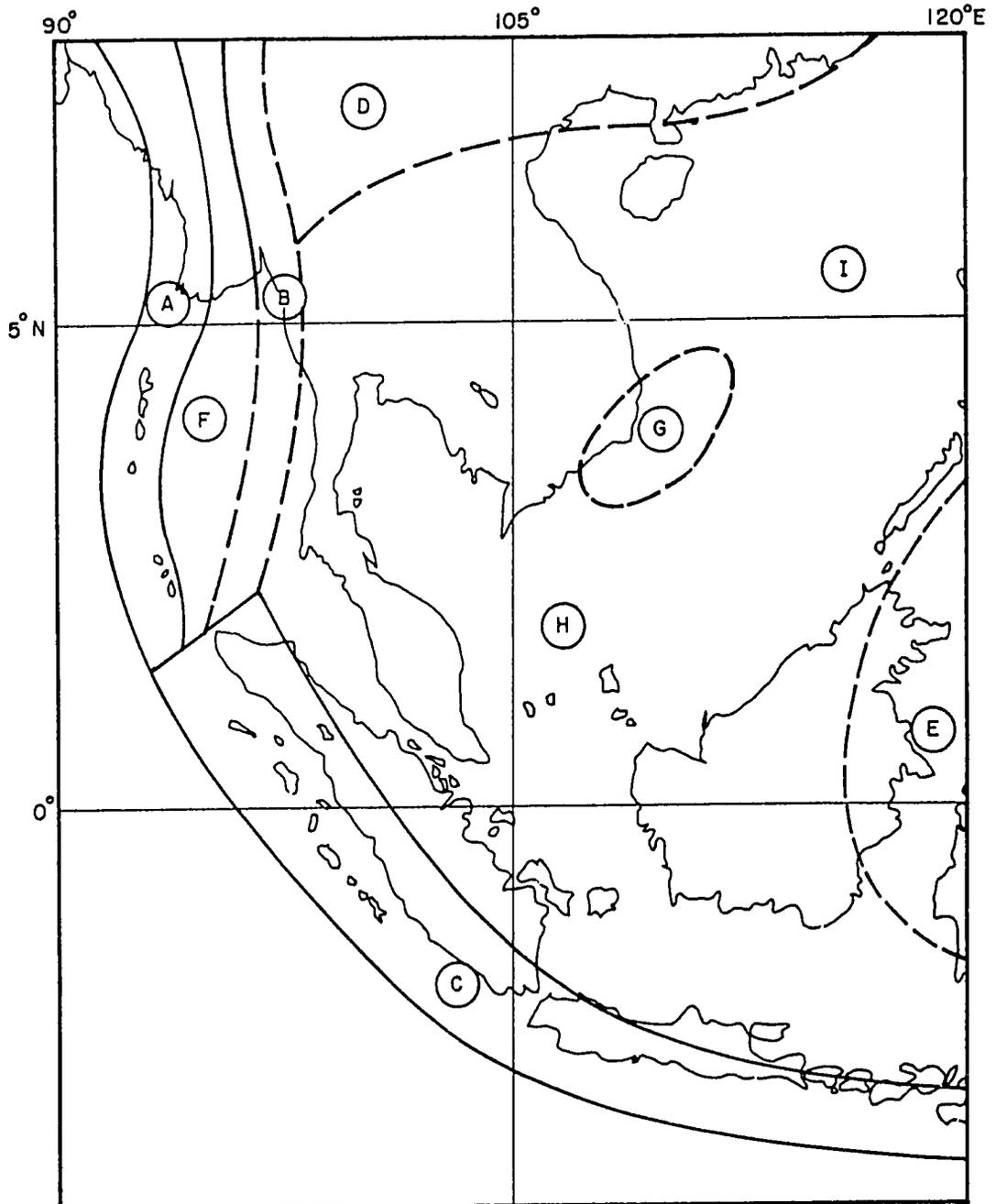


Fig.10 Seismotectonic Setting of the Malay Peninsula

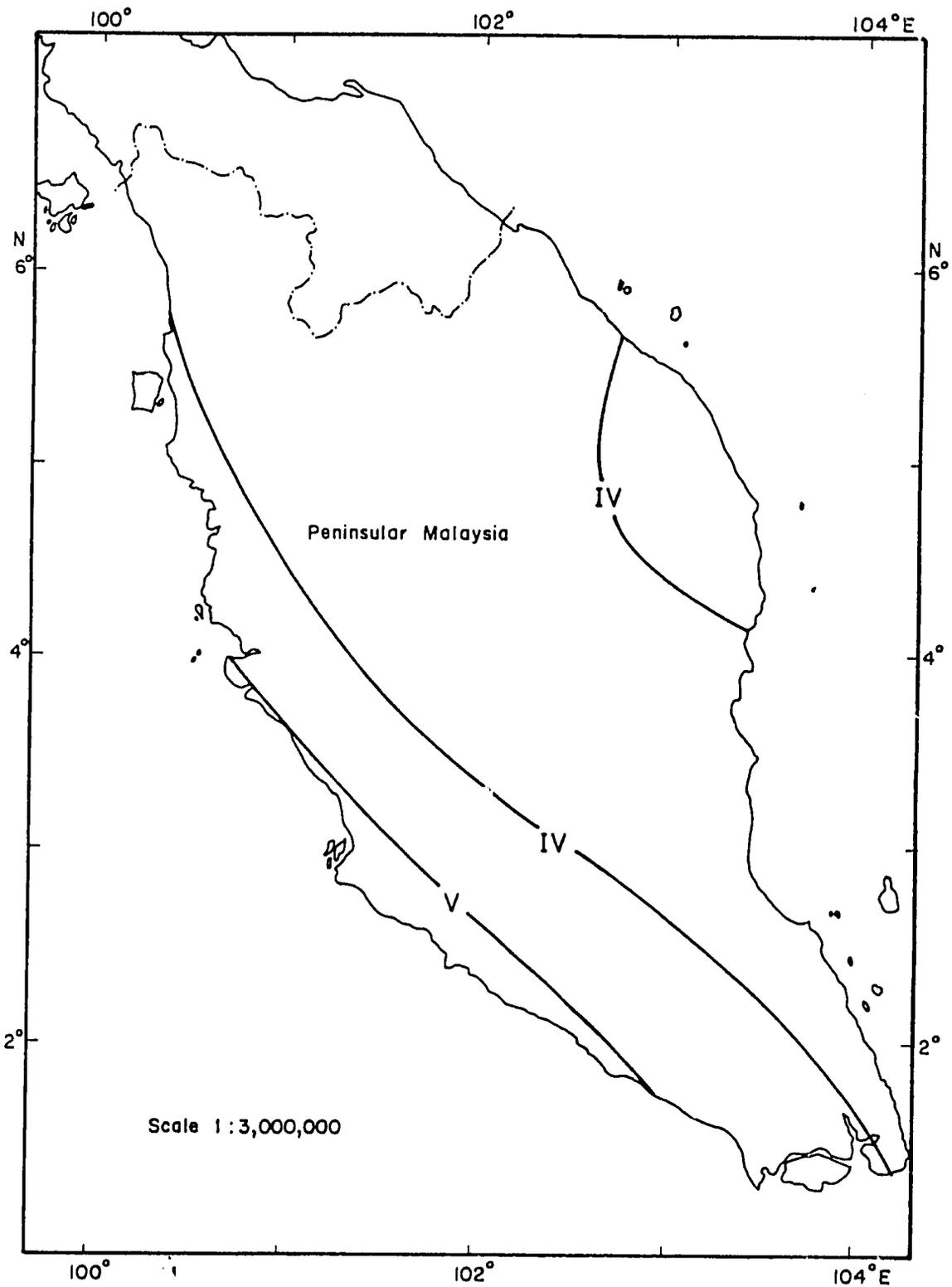


Fig.II Maximum Observed Intensity (MM Scale) Peninsular Malaysia (1805-1983)

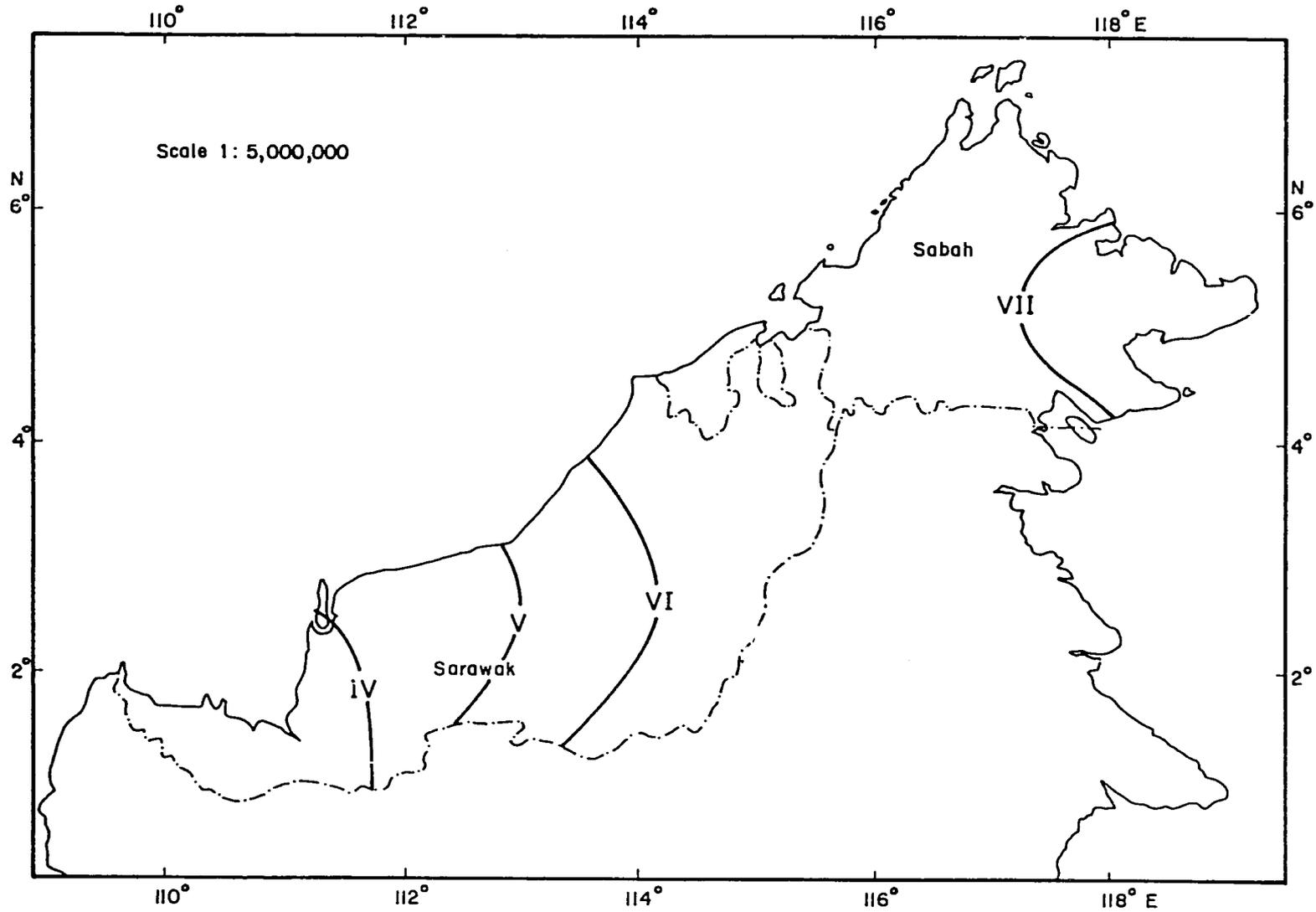


Fig.12 Maximum Observed Intensity (MM Scale) Sabah and Sarawak (1875 - 1983)

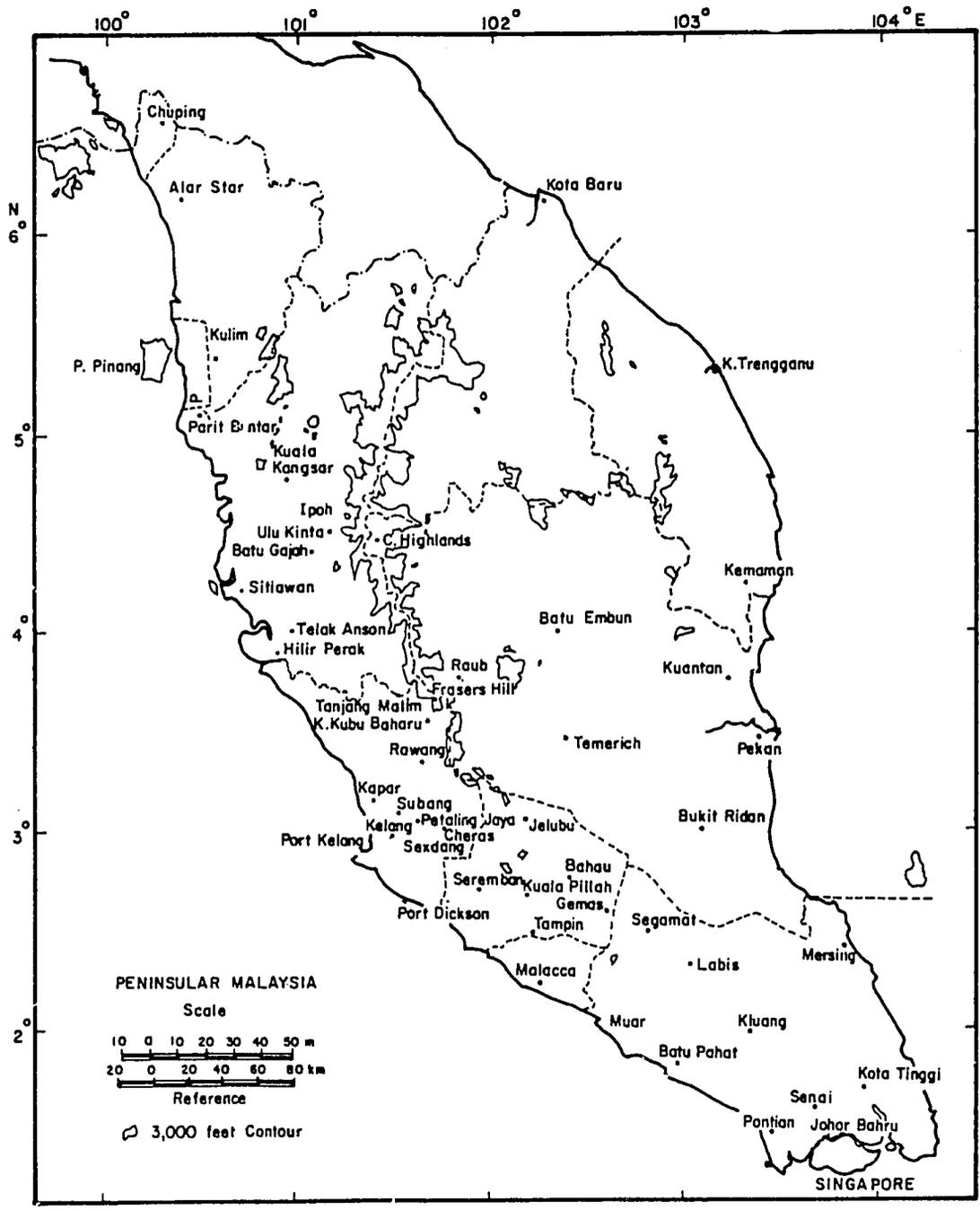
APPENDICES

APPENDIX I

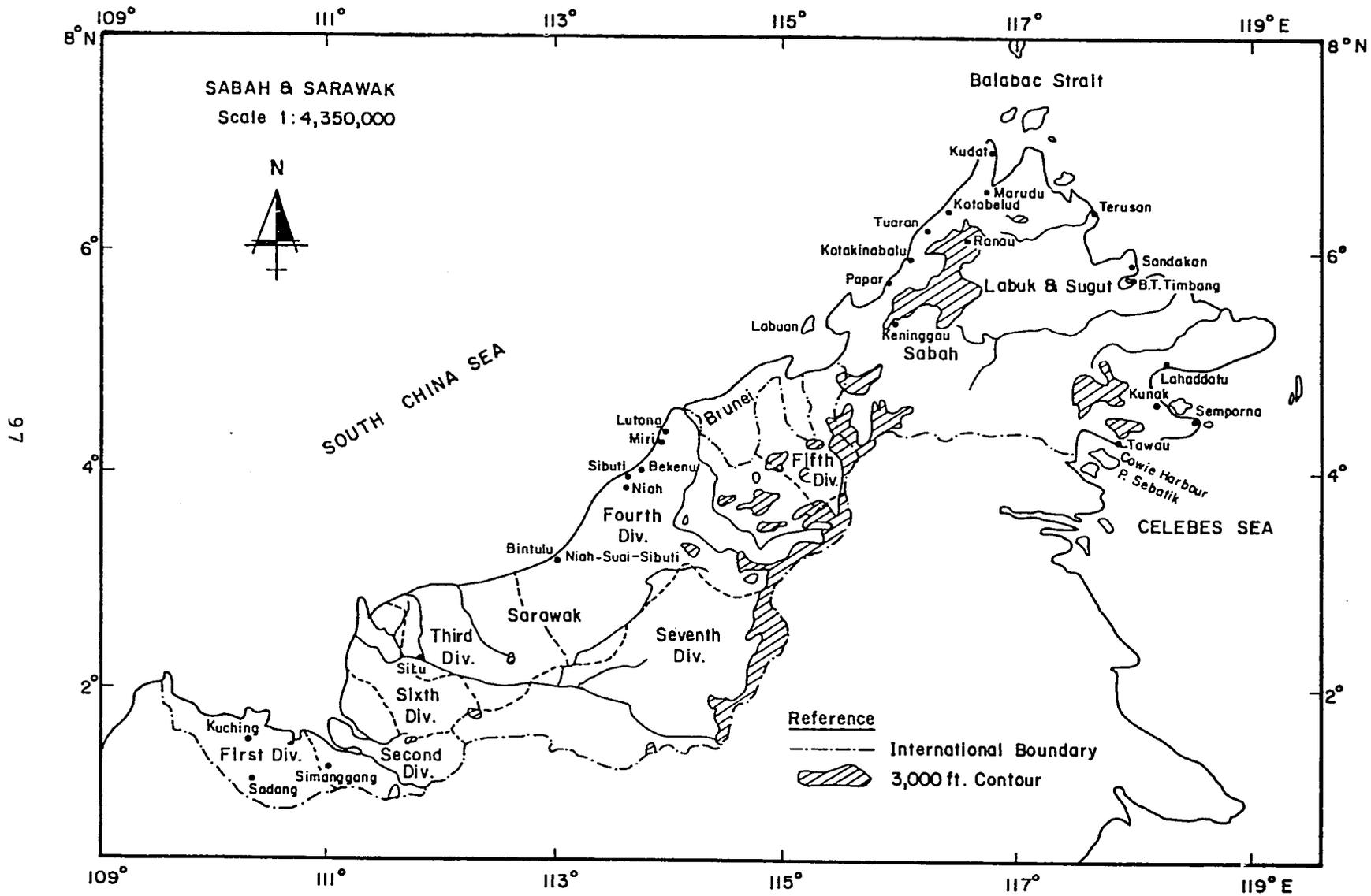
LOCAL TIMES (L.T.) OF MALAYSIA

For Peninsular Malaysia, the local time (L.T.) with effect from mid 1905 was 7 hours ahead of UTC. On Jan 1, 1933 an advance of 20 minutes was made in a daylight-saving plan, i.e. the local time became 7 hours 20 minutes ahead of UTC. On September 1, 1941, a further advance of ten minutes was effected so that the local time became 7 1/2 hours ahead of UTC. On January 1, 1982, a further advancement of half an hour was made so as to have one uniform time, called Malaysian Standard Time (MST), throughout Malaysia. With this adjustment, Malaysian Standard Time is now therefore 8 hours ahead of UTC.

For Sabah and Sarawak, the local time has been based on the eighth time zone throughout and is all the time eight hours ahead of GMT or UTC.



Appendix II Map of Peninsular Malaysia



Appendix III Map of Sabah and Sarawak

APPENDIX IV

MODIFIED MERCALLI INTENSITY SCALE OF 1931 (abridged)

- I. Not felt except by a very few under especially favourable circumstances.
- II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
- III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing truck. Duration estimated.
- IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably.
- V. Felt by nearly everyone; many awakened. Some dishes, windows, etc broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
- VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
- VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken. Noticed by persons driving motor cars.
- VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
- IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
- X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground

badly cracked. Rails bent. Landslides considerable from river banks and steep slopes; shifted sand and mud. Water splashed (slopped) over banks.

- XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
- XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.