QUATERNARY SHORE LINES OF THE SUNDA LAND SOUTHEAST ASIA

H.D. TJIA[1]

ABSTRACT

All frequently occurring positive shore lines and a few of the submerged strand lines of the Sunda Land, *i.e.* comprising the Sunda Shelf, Malayan Peninsula, eastern rim of Sumatra, South and West Kalimantan (Borneo), can be correlated with the classical examples of Quaternary shore lines of the Mediterranean and elsewhere. The submarine shore lines of the Sunda Land are at depths of −82-90 m, −67 m, −60 m, −50-51 m, −45 m, −36 m, −30-33 m, −28 m, −18-22 m, −13 m, −10 m, and −7 m. Elevated beaches above the present sea level are at +10-12 m, +16-18 m, +30-33 m, and +50 m. Variable sea levels of the past 6,000 years left traces at a few meters below till about 6 meter above the present sea stand.

Warping appears to be indicated along the western margin of the Sunda Land where on one side submergence amounting to 30 m and on the other side emergence of 30 m have occurred since the last glaciation.

INTRODUCTION

The Sunda Land comprises the Sunda Shelf and contiguous areas of tectonic basement – which became consolidated in pre-Jurassic or pre-Cretaceous times – in the Malayan Peninsula, eastern rim of Sumatra, and a large part of South and West Kalimantan (or Borneo; fig.1). This craton is the southeastern extension of the Asiatic continent. The Sunda Shelf itself is covered by the Java Sea and the southern parts of the South China Sea and the Gulf of Thailand (F a i r b r i d g e, 1966).

In the early twenties G.A.F. Molengraaff recognized the sub-aerial character of the Sunda Shelf bathymetry. This author and later workers were able to trace two large river systems on the shelf, the North Sunda River rising in Sumatra and West Kalimantan and debouching in the South China Sea near the Natuna islands, and the East Sunda River possessing tributaries in Java and South Kalimantan while debouching into the Bali Sea at the south end of Makassar Straits. Hydrographical surveys and faunistic studies have confirmed Molengraaff's findings (v a n B e m m e l e n, 1949).

For this paper the author collected data on elevated shorelines and submerged benches in order to attempt a correlation of the Quaternary strandlines with established Quaternary sea levels elsewhere. The tectonic stability of the Sunda Land, except presumably along its boundaries, should yield information on undeformed Quaternary shorelines.

The writer is grateful to S.R.M. Harvey, formerly senior geologist of Ocean Mining, Inc., who worked in Indonesia in 1967, and who unknowingly stimulated the compilation of the present report. Thanks are also due to Moh. Oentoeng, geophysicist of the Geological Survey, Indonesia, for his cooperation in furnishing unpublished information of recent work in the waters around the Indonesian tin islands.

QUATERNARY SEA LEVELS OF THE SUNDA LAND

Evidence of former sea levels. – On land strandlines higher than the present sea level are recorded as marine abrasion or depositional terraces, elevated

[1] Department of Geology, University of Malaya, Kuala Lumpur, Malaysia.

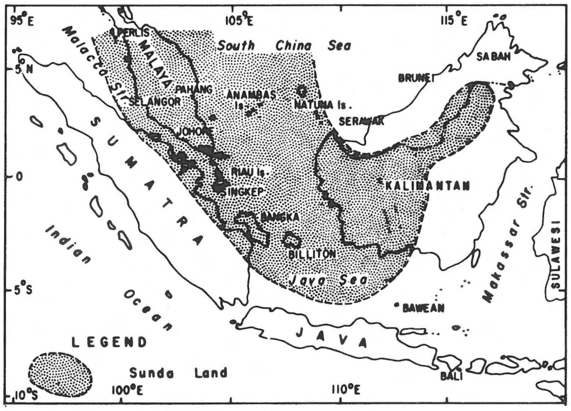


Fig. 1
Outline map of the Sunda Land area.

littoral sediments and beach ridges, and especially along limestone coasts as sea level notches. Offshore, former shorelines are indicated by submarine abrasion or depositional benches, slope breaks, and submerged littoral plus associated fluvial deposits. Data on former sea levels have been collected from the literature, unpublished drill hole records of the Indonesian tin islands, and from bathymetric contour maps constructed from a number of British and Dutch navigational charts. In the drilling records the recurrent depths of tin concentrations upon bedrock have been regarded to be associated with certain baselevels. It is logical to assume that the sea level responsible for each level of tin accumulation is higher than the elevation of the placer. Although this must be so (see e.g. information on North Kalmoa, Billiton, in Table I), yet the author believes that the differences are in the order of a few meters only. On the constructed bathymetric maps only those submarine benches which are clearly shown, have been considered to represent former baselevels.

There are few absolute ages known for Quaternary deposits of the Sunda Land. A 10-foot marine terrace in Perlis, West Malaysia, was radiocarbon-dated at 5,200 ± 200 yrs (A l e x a n d e r, 1961). Stigmaria standing erect in soft bedrock below a tin placer in Billiton were beyond the measuring range of the carbon isotope method, namely more than 55,000 yrs (K r o l, 1960). Billitonites (tektites) resting upon tin placers and sometimes also upon eluvial tin concentrations were shown by K-Ar dating to be 570,000 yrs (G e n t n e r & Z ä h r i n g e r, 1960). C i s s a r z & B a u m (1960) determined the age of a perched tin placer (locally called *menchang*) in a Bangka mine as 24,000 ± 2,000 yrs.

Outside the Sunda Land proper, adjacent Brunei and Sarawak areas have furnished absolute ages of 700,000 yrs for tektites associated with the warped Jerudong terrace (60-100 ft above sea level); 4,500-5,400 yrs for the 6-foot terrace; 2,170±150 yrs B.P. for a probable lower strandline (3-foot) as is indicated by drowned wood (W i l f o r d, et al. 1966; W i l f o r d, 1967).

Uncompacted and fresh-looking deposits of clastics are usually regarded to be of Quaternary age. Horizontal to sub-horizontal attitudes of sediments constitute an other criterion in relative age determination. The Billiton geologists, like O s b e r g e r (1965) believe that the tin placers have been accumulating since Early Pleistocene. These placers have been found together with the tektites already described, but may also be associated with elephant teeth estimated to be 2,000-4,000 yrs old.

F a i r b r i d g e (1961, 1966) has postulated that the Günz and Mindel glaciations did not lower the sea below the present level, because the global, Quaternary diastrophic eustasy caused by subsidence of quasi-cratonic crustal blocks – a.o. the South China Sea and the western Pacific basins – had not yet attained its maximum value. Only during the last two glaciations was the sea level sufficiently lowered by the combined effects of the tectonic and glacial eustasy to expose extensive areas of the present shelves.

Range of Quaternary sea levels, – The maximum depth of glacially depressed sea levels on the Sunda Shelf has been estimated to range between less than –100 m to –72 m (see U m b g r o v e, 1929). Worldwide comparisons led F l i n t (1957) to assign a maximum value of + 50 m for the highest interglacial sea stand above the present sea level. In the Insonesian Archipelago the post-Glacial "Daly" levels at about 5 m, 1.5-2 m, and 0.5-1 m above the present sea level have been well established. Comparisons with other areas indicate their respective ages to be 6,000 yr, 5,000 yr, and 3,500 yr B.P. Detail mapping in several areas in Java and specific observations in South Sumatra and SW-Sulawesi have led the present writer to postulate that the marine "Daly" levels have fluvial counterparts at similar levels above the current streams and can be traced till scores of kilometers inland and approaching absolute altitudes of almost 100 m (T j i a, 1968). In the next section the author states his opinion that the tin placers

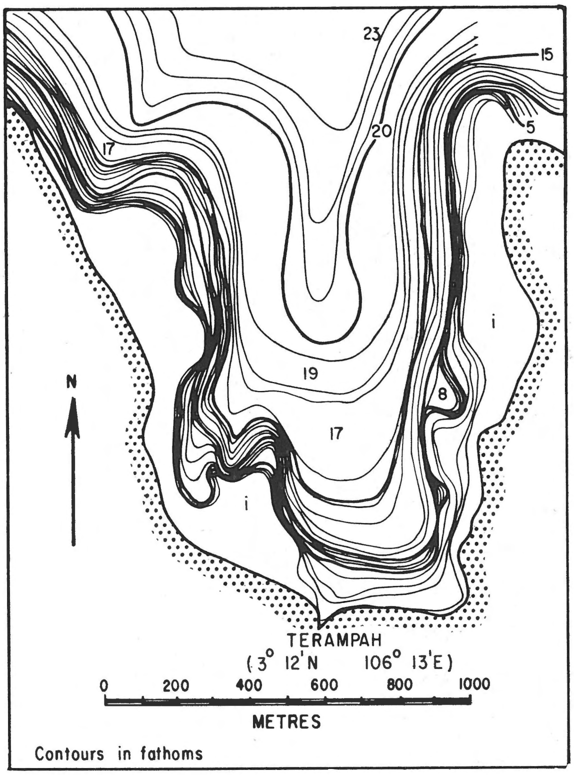


Fig. 2
Bathymetry of Terampah Bay, Siantan Island, Anambas Group. Note submerged benches at 1, 17, 20 and 23 (?) fathoms (1.8, 31, 36.5, and 42 meters).
Data from Royal Navy Admiralty Chart no. 2244, published in 1959.

below the land surface can be correlated to those which occur offshore at identical depths.

Bangka, Billiton, and Singkep. – Molengraaff (1922) reported that offshore tin placers were known at –17 m depth below the present sea level up to a distance of 1.5 km south off Singkep Island. Off the eastern coast of South Sumatra submarine banks were mentioned by van Tuyn (1932). Van Overeem (1960) listed a series of drowned strandlines encountered during offshore tin exploration around Billiton. The evidence comprises breaks in slope at –10 m, erosion or abrasion levels at –20 m and –30 m, hardpans at –16 m, –18 m, and, between –15 to –24 m, and at last a drowned valley bottom at –45 m. At the moment marine kaksas or tin placers are being won from general depths of –20 to –25 m below sea level.

Drilling and dredging records of marine mining areas around Billiton show recurrences of kaksas at depths of –17 to –18 m, about –22 m and –28 m (compare Table I). The logs further show benches at –8 m, –10 m, and –13 m,

Offshore Toboali, SW-Bangka, the drilling logs record tin placers at –10 m, –16 m, and –19 to 21 m depths. Onshore, Geursen (1933) showed storied tin concentrations at Air Mesu, Pangkalpinang, Bangka, where the kaksas are 7 m, 18 m, and 29 m below the surface of the coastal plain.

Above the present sea level terraces and marine deposits are known from Bangka and Billiton at +2 m, +6-8 m, and +18 m. The 18-meter terrace in the Ranggam Beds in Bangka has been considered to indicate warping, because elsewhere these beds occur at +4-5 m or even below sea level (Osberger, 1965). Furthermore, stream gradients and surface slopes in both islands show distinct breaks in slope at elevations between +50 m and +65 m.

Riau Islands. – Bothé (1928) described tin deposits in the Riau Islands from depths of 15-20 m, and 30 m below the land surface. The positions of these deposits are similar to those found for the producing tin islands farther south.

While on assignment in Bintan, the author noted that exploitable bauxite deposits most frequently occur between 25 m and 60 m above sea level. A top limit of mineable bauxite at +60 m is also indicated on the maps of the Central Riau Islands which were surveyed by Johnson & Marjono (1963). Since bauxitization is thought to be associated with peneplains and extended periods of tropical weathering, the +60 m level of bauxite deposits appears to be indicative of one erosion plane approximately at that altitude.

West Malaysia (Malayan Peninsula). – Various authors report the alluvial cover to amount to 120 m-130 m, which accumulated since the sea level was so much lower. These thicknesses have been proven to exist also upon non-calcareous bedrock (Richardson, 1947). Alluvial thickness also shows another shallower erosion level at approximately 50 m below the land surface.

Breaks in slope, ubiquitous at +75-80m in the western coastal regions and marine clastics at +75 m in Johore seem to indicate maximum Quaternary sea levels (Walker, 1956; Burton, 1964). Fitch (1949, 1951) following J.B. Scrivenor, attributed these indications of high shorelines to epirogenic

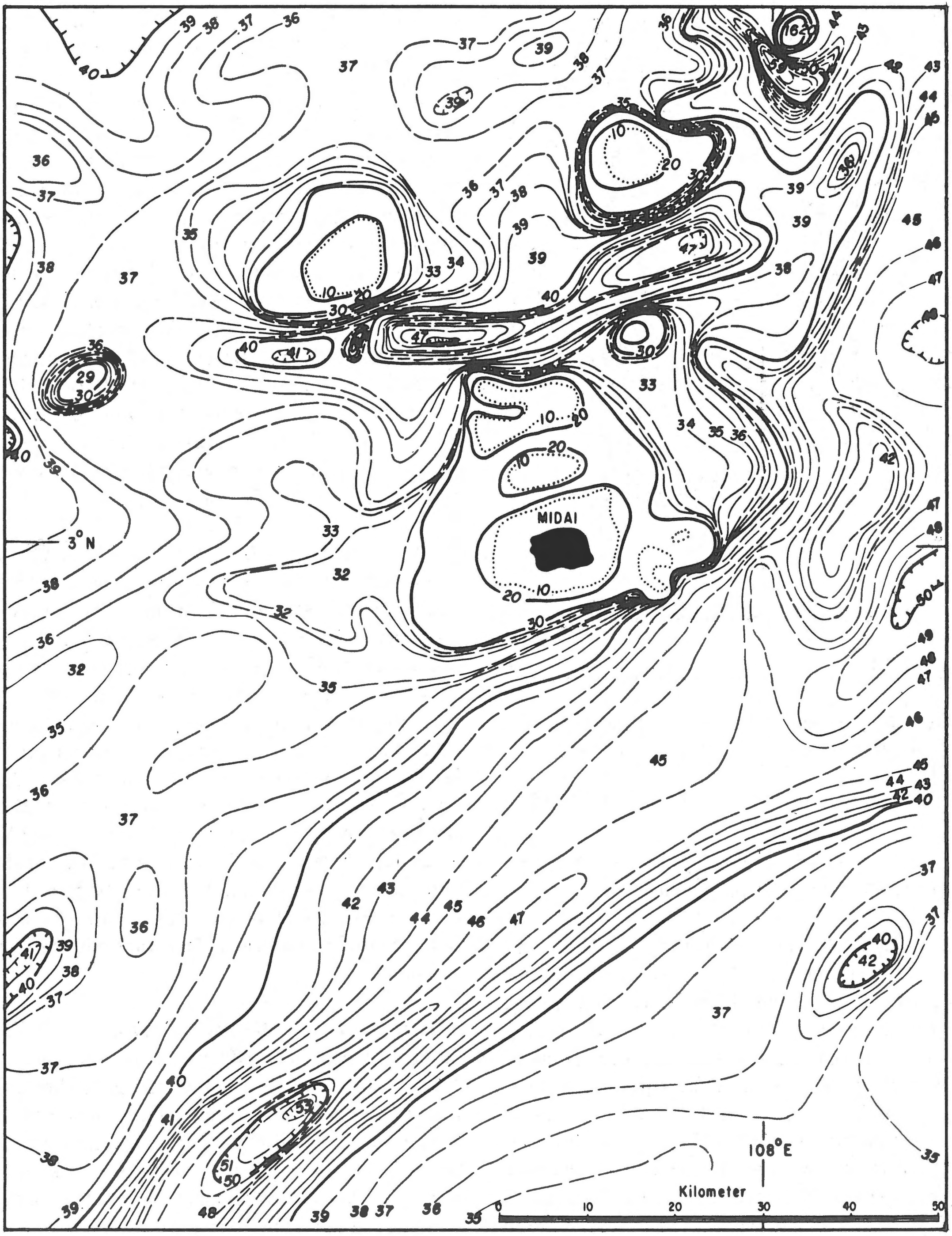


Fig. 3
Bathymetry of the Sunda Shelf in the vicinity of Midai Island, South China Sea. Note submerged benches at 32, 37, 39, and 45 fathoms (60, 67.5, 71, and 82 meters). The lower two flats may indicate drowned terraces of the North Sunda River channel, which is shown by the 40-fathom contour.
Data from Royal Navy Admiralty Chart no. 1311, published in 1955. Contours only completed for depths exceeding 30 fathoms.

TABLE I

Evidence of Quaternary Sea Levels.

Locality		Reference to present s.l. in meter	Type	Source
Bangka				
1.	Toboali, offshore	– 10.5	Tin placer	Drill logs
		– 15-16.5	Tin placer	Drill logs
		– 19-21	Tin placer	Drill logs
2.	Air Mesu, onshore	– 7*	Tin placer	Geursen, 1933
		– 15*	Tin placer	Geursen, 1933
		– 18*	Tin placer	Geursen, 1933
		– 29*	Tin placer	Geursen, 1933
3.	Tempilang, onshore	– 18*	Tin placer	Geursen, 1933
4.	Coasts of Bangka	+ 2	Corals	Verbeek, 1897
		+ 8	Terraces	Osberger, 1962
5.	Ranggam	+18	Terrace	Osberger, 1962
6.	Bangka, onshore	+50-65	Break in slope	Top. maps
Billiton				
1.	Manggar, onshore	– 7*	Tin placer	Adam, 1933
		– 16-18*	Tin placer	Adam, 1933
2.	Sungai Padang, offshore	– 10	Break in slope	van Overeem, 1960
		– 4-5	Valley bottom	van Overeem, 1960
3.	Teluk Pring, offshore	– 20-25	Tin placer	van Overeem, 1960
4.	Off North coast	– 15-24	Hard pans	van Overeem, 1960
5.	Off West coast	– 16	Hard pans	van Overeem, 1960
6.	Off East coast	– 18	Hard pans	van Overeem, 1960
7.	Off Billiton coasts	– 20	Erosion or abrasion levels	van Overeem, 1960
		– 30		van Overeem, 1960
8.	Tandjung Pandan, offshore	– 13	Bench in sediment	Drill logs
		– 20-22	Bench in sediment and tin placer	Drill logs
		– 25-26	Tin placer	Drill logs
		– 31	Bench in bedrock	Drill logs
9.	North Kalmoa, offshore	– 13	Bench in sediment	Drill logs
		– 17	Bench in bedrock	Drill logs
		– 17-19	Tin placer	Drill logs
		– 25-27.5	Bench in bedrock	Drill logs
10.	Tandjung Kubu, offshore	– 13	Bench in sediment	Drill logs
		– 17	Bench in bedrock	Drill logs
		– 22.5	Tin placer	Drill logs
		– 24	Tin placer	Drill logs
		– 28	Tin placer	Drill logs
11.	Sungai Padang, offshore	– 5-7	Bench in sediment	Drill logs
		– 8	Bench in sediment	Drill logs
		– 10	Bench in sediment	Drill logs
		– 10-12	Bench in bedrock	Drill logs
		– 15	Bench in bedrock	Drill logs
		– 20	Bench in bedrock	Drill logs

Locality	Reference to present s.l. in meter	Type	Source
12. Tandjung Siantu,offshore	– 8	Bench in sediment	Drill logs
	– 10	Bench in sediment	Drill logs
	– 20	Bench in bedrock	Drill logs
13. Billiton, East coast	+ 6	Terrace	van Overeem, 1960
	+ 18	Terrace	van Overeem, 1960
14. Billiton, S.E.	+ 25	Terrace	van Overeem, 1960
15. Billiton Island	+ 2	Corals	Verbeek, 1897
	+ 6-8	Marine shells	Osberger, 1962
	+ 50	Break in slope	Top. maps.
Singkep			
1. Dabo valley, offshore	– 17	Tin placer	Molengraaff, 1922
2. Off South coast	– 17	Tin placer	Molengraaff, 1922
Riau – group			
1. Riau Islands	– 15-20*	Tin accumulation	Bothé, 1925
	– 21-25*	Tin accumulation	Bothé, 1925
	– 30*	Tin accumulation	Bothé, 1925
2. Bintan Island	+ 60	Top limit of exploitation of bauxite	Field observation
West Malaysia (Malaya)			
1. Sungei Soi, Kuantan, Pahang	+ 16 (50 ft)	Alluvial flat	Fitch, 1949
2. Chukai, Trengganu	+ 5 (15 ft)	Beach ridge	Fitch, 1949
	+ 12 (35 ft)	Beach ridge	Fitch, 1949
3. Kuantan, Pahang	– 52* (160 ft)	Alluvium	Fitch, 1951
	+ 5 (15 ft)	Beach ridge	Fitch, 1951
	+ 12 (36 ft)	Beach ridge	Fitch, 1951
4. Northeast Johore	+ 6	Beach ridge	Nossin, 1962
5. Johore	– 49* (150 ft)	Marine clastics	Burton, 1964
	+ 75 (230 ft)	Marine clastics	Burton, 1964
6. East coast: Kuala Trengganu–K. Pahang	+ 10 (30 ft)	Beach ridge	Nossin, 1965
7. Selangor	> – 33* (100 ft)	Alluvium	Roe, 1949
8. Lapan Utara, Selangor	– 75* (220 ft)	Shells and unconsolidated sed.	Roe, 1951
9. West Coast	– 130* (400 ft)	Bedrock under alluvium	Walker, 1956
	+ 82 (250 ft)	Ubiquitous break in slope	Walker, 1956
	+ 30-36 (90-110 ft)	Coastal bench	Walker, 1956
	+ 3-5 (10-15 ft)	Raised shore line	Walker, 1956
10. Sitiawan, Perak	– 120* (–365 ft)	Alluvium upon phyllite	Willbourn, 1941
11. Dinding, Perak	+ 3	Beach ridge	Koopmans, 1964
	+ 6	Beach ridge	Koopmans, 1964
12. Perlis	+ 3 (10 ft)	Terrace	Alexander, 1961
13. Langkawi islands	> + 65 (200 ft)	Elevated shore lines	Scrivenor & Willbourn, 1923
14. Malayan Peninsula	+ 16 (50 ft)	Alluvium and terraces	Walker, 1956
Singapore			
1. Singapore Island	+ 16-33 (50-100 ft)	Alluvium	Scrivenor, 1924

	,ocality	Reference to present s.l. in meter	Type	Source
'hailand				
.	Thailand	< +50	Terraces	Sethaput, 1956
..	Peninsular Thailand, West Coast	+ 3-12	Terraces	Sethaput, 1956
.	Peninsular Thailand, East Coast	– 30*	Alluvium	Sethaput, 1956
.	Bangkok	– 300*	Alluvium	Sethaput, 1956
'ietnam				
.	Vietnam	– 40	Würm beach sed.	Saurin, 1956
		+ 2	Holocene terrace	Saurin, 1956
		+ 4	Holocene terrace	Saurin, 1956
'unda Shelf				
.	Tambelan and Badas islands	– 31-32	Submarine bench	British Admiralty Chart no. 1312
		– 36.5	Submarine bench	
		– 49.5-51	Submarine bench	
		– 60.5	Drowned fluvial terrace	
.	Midai Islands	– 60.5	Submarine bench	British Admiralty Chart no. 1311
		– 67.5	Submarine bench	
		– 71	Submarine bench	
		– 82	Drowned fluvial terrace	
.	Area east of Great Natuna Island	– 82-88	Submarine bench	British Admiralty Chart no. 1311
		– 90	Drowned fluvial terrace	
		– 95-97	Submarine bench	
.	South Natuna Is.	– 18-22	Submarine bench	British Admiralty Chart no. 2104
		– 31-32	Submarine bench	
		– 36.5	Submarine bench	
		– 44-45.5	Submarine bench	
		– 51-55	Submarine bench	
		– 60.5	Submarine bench	
.	Area south of NE group Anambas Is.	– 50	Submarine bench	British Admiralty Chart no. 2244
		– 54	Submarine bench	
		– 60.5	Submarine bench	
.	Terampah Bay, Siantan Island, Anambas group	– 1.8	Submarine bench	British Admiralty Chart no. 2244 1 : 15,000
		– 31	Submarine bench	
		– 36.5	Submarine bench	
		– 42 (?)		
ast Malaysia				
.	East Malaysia	+ 5	Coral reefs	Fitch, 1954
		+50	Coral reefs and terraces	Fitch, 1954
.	Kuching Airfield Sarawak	+30	Terrace	Haile, 1949
.	Brooketon to Tutong, Brunei	+16-20	Terrace	Fitch, 1954
.	Miri, Sarawak	+40	Terrace	Wilford, 1951
		+12-13	Terrace	Wilford, 1954

Land surface is datum plane.

uplift of the peninsula as isostatic adjustment to denudation. Other shoreline levels are at +33 m, + 16 m, and +10-12 m, while the post-Glacial "Daly" levels are well represented by beach ridges at +3 and +6 m elevations.

Sunda Shelf. – The bathymetric configuration of the submarine part of the Sunda Land has been constructed from data on British and Dutch navigational charts. The contouring was only attempted for depths exceeding 20 fathoms, except in the case of Terampah Bay, on account of the scales of the charts. Figure 2 and 3 are samples of the bathymetry of the Sunda Shelf.

Common submarine benches or slope breaks on the parts of the shelf studied are at depths of: –2 m, –18-22 m, –31-32 m, –36 m, –44-45 m, –50-51 m, –60 m, and –82-88 m. Moreover, the deepest recognizable levels on the charts appear to be at –90 m and –97 m below the present sea level.

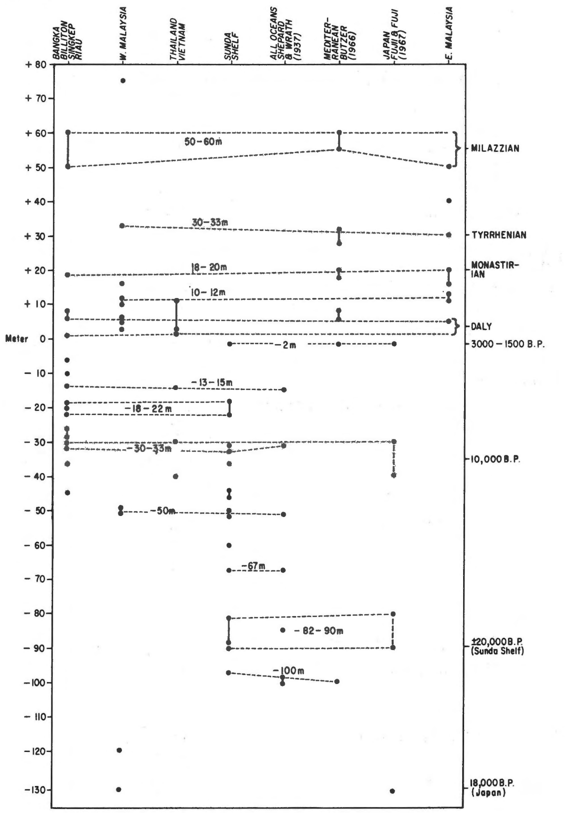
Thailand and Vietnam. – The continental parts of Southeast Asia adjacent to the Sunda Land comprise a.o. Thailand and Vietnam. S e t h a p u t (1956) listed the following figures of common terrace elevations and thicknesses of alluvium: –30 m, +3-12 m, and less than +50 m. The extraordinary alluvial thickness near Bangkok amounting to 300 m must be ascribed to tectonic subsidence in addition to a low glacio-eustatic sea level. In Vietnam Würmian littoral deposits have been recorded at –40 m depth (S a u r i n, 1956).

QUATERNARY SEA LEVELS OF SUNDA LAND AND ELSEWHERE

S h e p a r d (1963) has reported that a worldwide shelf break occurs at a depth of –72 fm (–132 m). This level is also found in Japan (F u j i i & F u j i, 1967). Furthermore, a 10-fathom bench is also common. Table II lists comparisons of the various common levels of the Sunda Land with Quaternary levels from a few localities elsewhere.

TABLE II

Recurring Shorelines of the Sunda Land and Correlation Chart.



The table shows that the lowest sea level in the interinsular part of the Sunda Land was –97-100 m lower than today. It appears that the –120 m and –130 m depth of bedrock below the alluvium along the western margin of the Sunda Land, *i.e.* (western part of the Malayan Peninsula) is due to downwarping. In the Sunda Land the successive shorelines were at –82-90 m, –67 m, –60 m, –50-51 m, –45 m, –36 m, –30-33 m, –28 m, –18-22 m, –13 m, –10 m, and –7 m below the present sea level. Raised shorelines of the Sunda Land frequently occur at slightly over sea level to about +6 m (the "Daly" sea levels), +10-12 m, +16-18 m, +30-33 m, and +50 m, The +75-82 m level which is so ubiquitous in the western part of the Malayan Peninsula may also point to marginal warping. It is possible that along the western boundary of the Sunda Land tilting caused one zone to subside to –130 m depth (about 30 m deeper than the lowest Quaternary sea level found on the Sunda Shelf proper), while an adjacent zone was elevated to +75-82 m (also about 30 m higher than the highest Pleistocene shoreline recorded in the central part of the Sunda Land). This mild deformation of the crust must have occurred after the +50 m level and after the –100 m strandline – by the majority of Quaternary geologists accepted to indicate the last glaciation.

As Table II shows, the positive shorelines of the Sunda area are in the range of those determined in the Mediterranean region. Of the submarine shorelines of the Sunda Shelf only a few can be correlated with reasonable accuracy with those in other localities. This fact only shows the imperfect knowledge of submerged sea levels of the Quaternary.

One should also bear in mind that correlation of former sea levels by their respective elevations alone should only be regarded as a tentative attempt. Shepard (1963) has shown that elevated shorelines of the Hawaiian Islands with identical altitudes as the "Daly" levels indicate radiometric ages of 20,000 yr and 31,000 yr. This shows, that tectonic disturbances modified the elevations or that sea levels of various ages may have had duplicate altitudes.

REFERENCES

Adam, J.W.H. (1933) – Kaksa-genese. De Mijning. in N.I., 14, p.1-5, 20-26, 81-87, 161-171.

Alexander, J.B. (1961) – A short outline of the geology of Malaya, with special reference to Mesozoic orogeny. Geol.Surv.Dept.Fed. Malaya Rept. no.61/P/031/8 (unpublished).

Bemmelen, R.W. van (1949) – The geology of Indonesia. The Hague, Martinus Nijhoff, vol. IA.

Bothé, Ch.D. (1925) – Het voorkomen van tinerts in den Riau-archipel en op eilandengroep van Poelau Toedjoe (Anambas en Natoena eilanden). Versl.Med. Indische Delfst. no.18, p.1–42.

Burton, C.K. (1964) – The Older Alluvium of Johore and Singapore. J. trop. Geogr., 18, p.30-42.

Butzer, K.W. (1966) – Mediterranean area: Quaternary history. "The encyclopedia of oceangraphy", R.W. Fairbridge, ed.; New York, Reinhold Publ. Co., p.485-490.

Cissarz, A. & Baum, F. (1960) – Vorkommen und Mineralinhalt der Zinnerzlagerstätten von Bangka, Indonesien. Geol.Jahrb., 77, p.541-580.

Fairbridge, R.W. (1961) – Eustatic changes in sea level. London, Pergamon Press,, L.H. Ahrens *et al.* (ed.) "Physics and chemistry of the earth", p.99-185.

—— (1966) – The encyclopedia of oceanography. New York, Reinhold Publ.Co., p.479-485, 891-893.

Fitch, F.H. (1949) – Evidence for recent submergence of the land in East Pahang. J.Malay.Brch. R.Asiat,Soc., 22, p.115-122.

—— (1951) – The geology and mineral resources of the neighbourhood of Kuantan, Pahang. Geol.Surv.Dept. Fed. Malaya, mem. 6 (n.s.), p.1-144.

—— (1954) – Tertiary to Recent sea-level changes and their effect on British Borneo physiography. Geol. Surv.Dept. Brit.Terr. Borneo, Ann.Rept. for 1953, p.20-37.

Flint, R.F. (1957) – Glacial and Pleistocene geology. New York, John Wiley & Sons, Inc., Ch. 15.

Fujii, S. & Fuji, N. (1967) – Postglacial sea level in the Japanese Islands. J.Geosc. Osaka City U., 10, art.1-6, p.43-51.

Gentner, W. & Zähringer, J. (1960) – Das Kalium-Argon Alter von Tektiten. Z.f. Naturf., 15A, H.21.

Geursen, G.J. (1933) – Kaksa "und kein Ende". De Mijning. in N.I., 14, p .176-178.

Haile, N.S. (1949) – The geology of an area south of Kuching. Geol.Surv. Dept. Brit. Borneo for 1949, p.48-51.

Johnson, R.F. & Marjono (1963) – Geology and bauxite deposits in the Central Riau islands, Indonesia. Publ. Tek. Ser.Geol.Ekon. no.6, Direktorat Geol. Indonesia, p.1-54.

Koopmans, B.N. (1964) – Geomorphological and historical data of the lower course of the Perak River (Dindings). J.Malay.Brch. R.Asiat.Soc., 37, p.175-191.

Krol, G.L. (1960) – Theories on the genesis of "kaksa". Geol. Mijnb., 39, p.437-443.

Molengraaff, G.A.F. (1922) – "De zeeën van Nederlandsch Oost-Indië", p.272-357. Leiden, E.J. Brill.

Nossin, J.J. (1962) – Coastal sedimentation in Northeastern Johore (Malaya). Z. Geomorph., 6, p.296-317.

—— (1965) – Analysis of younger beach ridge deposits in Eastern Malaya. Z. Geomorph., 9, p.186-208.

Osberger, R. (1962) – Zur Geologie der Insel Billiton. Belitung Tin Mines, p.1-171 (unpublished).

—— (1965) – On the geology of the Indonesian part of the great Asian tin girdle. Gen. Managing Board of the Tin Mines, Symposium (unpublished).

Overeem, A.J.A. van (1960) – The geology of the cassiterite placers of Billiton (Indonesia). Geol. Mijnb., 39, p.444-457.

Richardson, J.A. (1947) – An outline of the geomorphological evolution of British Malaya. Geol.Mag., 84, p.129-144.

Roe, F.W. (1949) – Progress report on geological work in Selangor. Geol. Surv.Dept. Fed. Malaya, Rept. for 1948, p.24-37.

—— (1951) – The geology and mineral resources of the neighbourhood of Kuala Selangor and Rasa, Selangor, Federation of Malaya; with an account of the geology of Batu Arang Coal-field. Geol. Surv.Dept. Fed. Malaya, Mem. no. 7, p.1-163.

Saurin, E. (1956) – Indochine. Lexique Stratigraphique International. Comm. Stratigr., Congr.Géol.Int., 1, Asie,fasc. 6a.

Scrivenor, J.B. & Willbourn, E.S. (1923) – The geology of the Langkawi Islands with a geological sketch map. J. Malay. Brch., Asiat. Soc., v.l.

Scrivenor, J.B. (1924) – The geology of Singapore Island, J. Malay. Brch. Asiat, Soc., 2, p.1-8.

Sethaput, V. (1956) – Thailand. Lexique Stratigraphique International. Comm. Stratigr., Congr. Géol. Int., 3, Asie, fasc. 6c, p.50-52.

Shepard, F.P. & Wrath, W.F. (1937) – Marine sediments around Catalina island, Jour. Sed. Petrology, 7, p.41-50.

Shepard, F.P. (1963) – Submarine geology. New York, Harper & Row, 2nd ed., p.267 etc.

Tjia, H.D. (1968) – Fluvial correlates of "Daly" levels. Z. Geomorph., 12, H.2.

Tuyn, J. van (1932) – Over de rangschikking der Duizend-eilanden in noord-zuidelijke richting. De Mijning. in N.I., 13, p.132-134.

Umbgrove, J.H.F. (1929) – The amount of maximal lowering of sea level in the Pleistocene. Proc. Fourth Pac.Sc. Congr., Java, 2A, p.105-113.

Verbeek, R.D.M. (1897) – Geologische beschrijving van Banka en Billiton. Jaarb.Mijnw. in N.I., 15, p.1–272. with atlas.

Walker, D. (1956) – Studies on the Quaternary of the Malay Peninsula. I. Alluvial deposits of Perak and the relative levels of land and sea. Fedn. Mus. J., 1-2, p.19-34.

Willbourn, E.S. (1941) – Report for 1940, Geol. Surv. Dept., F.M.S., p.1-14.

Wilford, G.E. (1951) – Marine platforms and erosion features at Miri, Sarawak. Geol.Surv.Dept. Brit. Borneo, rept. GS.109/49/31 (unpublished, mentioned by F.H. Fitch, 1954).

—— (1967) – The effects of Late Tertiary and Quaternary tectonic movements on the geomorphological evolution of Brunei and adjacent parts of Sarawak. J. Tropical Geogr., 24, p.50-56.

Wilford, G.E., Collenette, P. & Kirk, H.J.C. (1966) – Radio-carbon determinations on specimens from Sabah. Geol. Surv. Rept. 1966, Borneo Region, p.83.