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Preliminary synthesis of the geology of Bangka Island, Indonesia

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Abstract: The paper reviews previous work and presents new data on the geology of Bangka Island based on photogeological and field investigations.

Stratigraphy of Bangka Island consists of four major units:
Ranggam Group - Upper Tertiary-Quaternary;
Fan Formation - Lower Tertiary;
Tempilang Sandstone - Middle to Upper Triassic; and
Pemali Group - Upper Palaeozoic.

The Pemali Group is thought to have been deposited in a deep marine environment whereas the overlying Tempilang Sandstone reflects shallower conditions and is probably a slope deposit. At the latest stage of the position of the Tempilang Sandstone, thrusting, granitization and uplift took place (Upper Triassic to Lower Cretaceous). In the following relaxation period, north-south high angle cross faulting occurred with major horizontal movements. Some minor fine grained leucogranites were emplaced during this period. The fluvial sedimentation took place during and after the cross faulting. The Fan Formation of Lower Tertiary age, which is the older fluvial unit, is unconformably overlain by the Ranggam Group. Since the latest stage of Ranggam Group deposition, several static sea level changes resulted in deposition of the marine sediments that are now found at low elevations around the island.

INTRODUCTION

The inverted S-shaped island of Bangka lies to the east of south Sumatra and occupies about 11,340 km^2 (Figure 1). Most of this is covered with low rounded hills of about +50 metres elevation, separated by wide and flat valleys. Maras Hill, the highest on the island, reaches 692 metres above sea level.

Although the island has been exploited for tin since 1711, its geology is still poorly known. This is partly due to scarcity of outcrops because of deep weathering and thick forest cover, and partly due to a lack of fossils.

The present paper gives an interpretation of the geology of Bangka, based on field investigations carried out while implementing current programmes for the Southeast Asia Tin Research and Development (SEATRAD) Centre and on photogeological work on a 1:100,000 scale.

PREVIOUS WORK

The literature existing before 1965 has been described by Osberger in that year. In summary, from 1872 to 1897, a series of papers were published by Dutch engineers. The first extensive publication was by Verbeek (1897). He considered the sedimentary units of the island as presumably Palaeozoic and the granitic intrusions as late Palaeozoic. The first large-scale geological map (1:100,000) of the island was published by the Bangka Tin Winning Company in 1920. Later, Zwierzycki (1929, 1933) and Westerveld (1936) added much to the

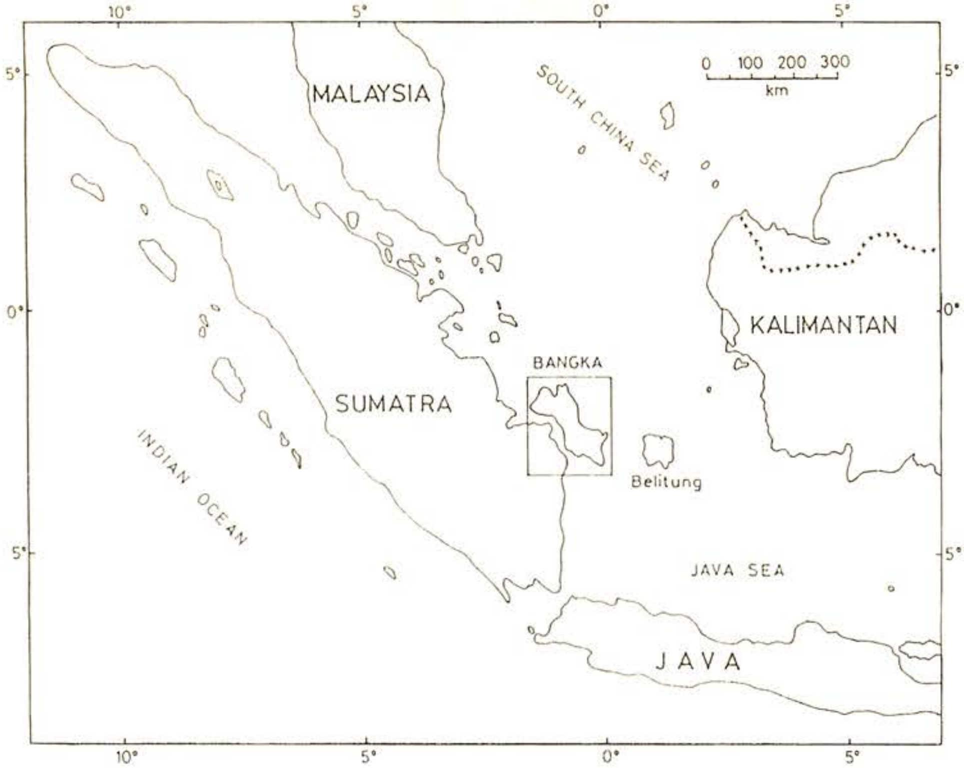

Fig. 1. Location map of Bangka.

knowledge of the geology of Bangka. A Triassic fossil (*Daeonella*) was found on Lingga Island to the north by Bothe in 1925, leading Zwierzycki and Westerveld to think of the pre-Tertiary units of the island as Triassic. In 1937, Wing-Easton described part of the stratigraphy and some of the intrusive rocks of the island, but with an emphasis on mineralization.

Firm evidence of the age of the stratigraphic units of Bangka was reached when Upper Triassic (Norian ?) corals, sponges, crinoids and Permian fusulinidae were found by De Roever in the Lumut Valley and at Air Durin village, respectively in 1947. The fossils were determined by De Neve and the results published in 1947 and 1951. Upper Triassic fossils were collected from a grey fragmented limestone that occurred as lenses within an intricately folded formation of phyllite, quartzite and conglomerate. The conglomerate contains pebbles of effusive rocks, radiolarian chert and limestone. De Neve mentioned some nearby occurrences of altered effusive rock (basaltic, andesitic) and red to greyish green chert-like schistose quartzites, and clearly described the presence of a major fault zone at that locality. A Permian fossil was found in a white silicified limestone sample belonging to the Bandung Museum. De Roever visited the sample locality and described the lithology as dynamo-metamorphic shales, arenaceous shales, pyritic black shales and very fine grained quartzite with several limestone intercalations.

Van Bemmelen (1947) described the stratigraphy of the island in his comprehensive work on the "*Geology of Indonesia*". In 1960, Cissarz and Baum studied the island and described the Palaeozoic rocks as dynamo-metamorphosed and the Triassic units as unaltered, calling them the "*Shale and Sandstone Series*".

A significant rock unit was described from southern Bangka by Zwartkruis (1962) and called "*Diamictite*". However, it is undoubtedly the "*Pebbly Mudstone*", that can be traced northward into North Sumatra, West Malaysia, peninsular Thailand, peninsular Burma and also occurs in South Himalaya.

A summary and discussion of the geology of the island was given by Osberger (1965), pointing out that both Permo-Carboniferous and Triassic units are partly dynamo-metamorphosed and partly unaltered. He thought this feature was due to folding and concluded there was no basic lithologic difference between the two units. He discussed the probable existence of a pre-Carboniferous unit on the island and also described the Upper Miocene-Lower Pleistocene unit (Ranggam beds) of the island.

The structure of the island has been discussed by various authors, worthy of note are Verbeek (1897), who mentioned the north-south Kelabat Fault, Hovig (1920) and Zwierzycki (1929), who extended the Kelabat Fault southward to the east coast of Sumatra. Detail and systematic structural investigations of north Bangka were first carried out by Kahr in 1958, who described the presence of faults/joints/fractures in many strike directions; maxima occurred in north, northeast, east and southeast with northeast and southeast being dominant. Tjia (1964) also mentioned the same feature in Lingga archipelago to the north. He considered it to be the result of a regional northeast-southwest horizontal compression and subsequent extension. In 1965, Osberger studied the structure and its relation to the granitic intrusions. He described the Kelabat Fault of Verbeek as "*apparently young ....with small vertical and horizontal (?) movements and downwarping over a large area to the west*". In 1967-68, Katili carried out a structural analysis of the island, based on data collected by Westerveld (1936), Kahr (1958) and students from the Bandung Institute of Technology. He found that the fold axes on the island form an S-shaped pattern, while the folding itself may have taken place in the Upper Jurassic, and thought it should be contemperaneous with the granitic intrusions. He also described a probable older fold pattern, deviating from the general (younger) fold axis direction.

The plutonic rocks, all of which were considered granites, of the island were described by various authors: Verbeek (1897), Zwierzycki (1920), Westerveld (1936, 1936a), Kieft (1952) and Wing-Easton (1937). However, after Aleva's study in 1960 of the plutonic rocks of Belitung Island, Osberger (1965) mentioned that not all magmatic rocks on Bangka were granites in the modern sense. Priem *et al.*, in 1974 collected 4 granitic samples from the island and several from neighbouring ones to be used for isotope geochronology. They measured a Rb-Sr isochron age of 217 ± 5 Ma, a K-Ar average age of 214 ± 4 Ma and a $^{87}Sr/^{86}Sr$ ratio of 0.7152 ± 0.0029. They concluded that the age of the granites in the area lies probably around the Norian-Rhaetian boundary.

The Tertiary to recent off-shore geology between Bangka and Singkep Islands was investigated with acoustic profiling by Aleva in 1972. He described the presence of at least three sedimentation cycles since Miocene-Pliocene time. No marine fossils have been found in the

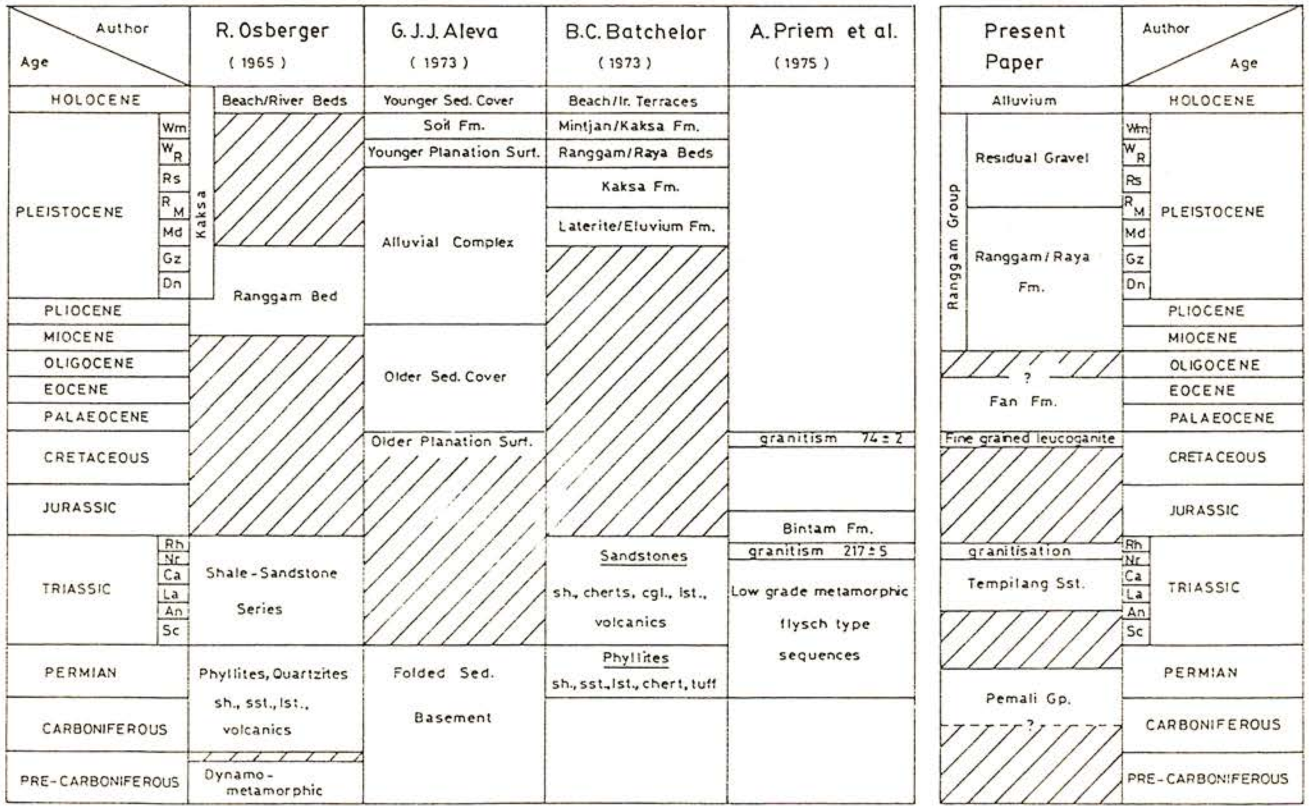

Fig. 2 Correlation chart based on preceding and present work.

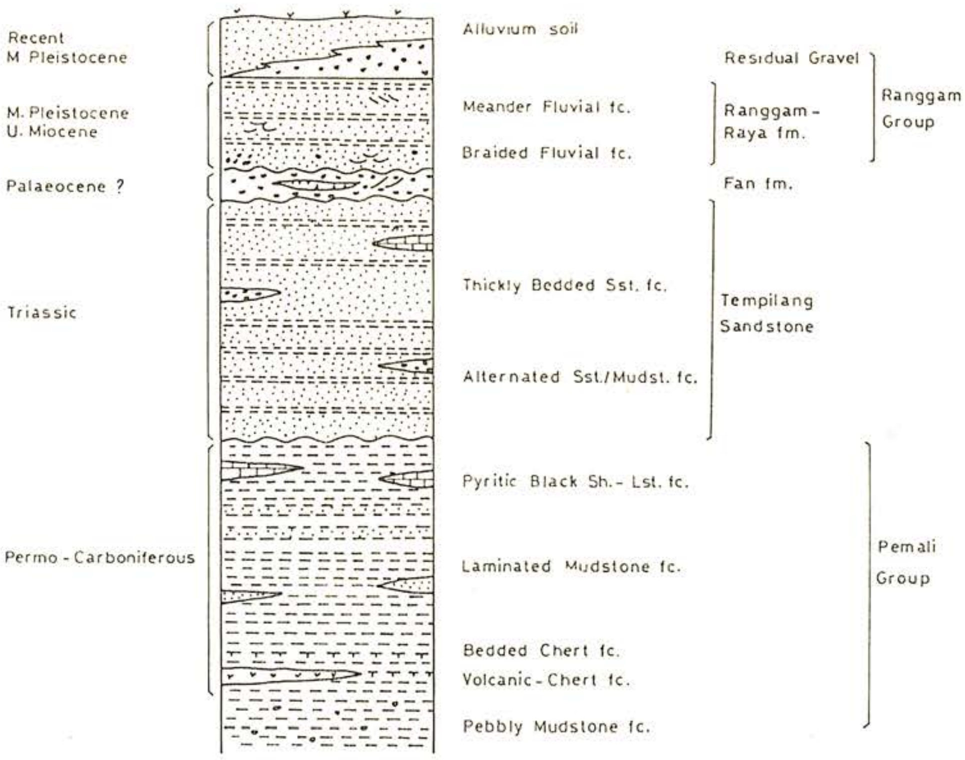

Fig. 3. Schematic columnar section.

sediments except in the overlying recent marine mud. A more detailed account of the geology and mineralization of Bangka and its surrounding was given by Batchelor (1973). The late Tertiary and Quaternary units were described in much detail because of their economic importance.

Interpretation of synthetic-aperture radar (SAR) imagery of Bangka was carried out by Cook (1979), but without discriminating between individual pre-Tertiary units or differentiating between the various faults.

STRATIGRAPHY

Four basic stratigraphic units can be distinguished on the island, two in the basement units and two in the overlying units. The basement units are presumably of Upper Palaeozoic to Upper Triassic in age and the overlying units are of Tertiary to Quaternary age (Figures 2 and 3).

They are informally named:

- Ranggam Group (Upper Tertiary-Quaternary);
- Fan Formation (Lower Tertiary ?);

– Tempilang Sandstone (Middle-Upper Triassic); and
– Pemali Group (Upper Palaeozoic).

PEMALI GROUP

This unit consists predominantly of mudstone and can be clearly discriminated on the aerial photographs by its fine texture, steep dip and isoclinal folding. According to field observations the unit comprises five facies:

- Pyritic black shale-limestone facies;
- Volcanic-chert facies;
- Bedded-chert facies;
- Laminated mudstone facies; and
- Pebbly mudstone facies.

No direct relationship among the facies is seen in the field and because of complex structure, the above mentioned order should not be considered as stratigraphical.

Pebbly mudstone facies

This facies is seen only at the southernmost part of the island in the Toboali district. Emmichoven and De Roever (in Zwartkruis, 1962) briefly mentioned this unit in 1941 and in 1951, respectively. In 1962, Zwartkruis discussed the unit in detail and called it "*the diamictite or slightly conglomeratic sandy mudstone*".

This is a thickly bedded dark grey mudstone or wacke stone with disseminated pebbles, commonly of quartz, granite, quartzite, gneiss, granodiorite, aplite, quartzo-feldspathic rock and rare volcanic rock. Clasts are subrounded to subangular and commonly of 0.5 to 3 cm in diameter but in very rare cases a 25 cm pebble of granite is seen (De Roever, 1951). The unit dips steeply to the northeast and near the granite it is metamorphosed to hornfels.

The unit is interesting because of the presence of pebbles. Zwartkruis thought it was deposited by a mudflow. Elsewhere in Southeast Asia, similar lithologies have been interpreted as glacial-related deposit (Ridd, 1970); Gobbett (1973) thought that the sediment was deposited in a rapidly varying environment not far from a shore with the pebbles dropping into the mud from above after having been carried in floating masses of vegetation; Garson *et al.*, (1975) considered it a continental margin mass flow deposit; and Page *et al.*, (1978) and Cameron *et al.*, (1980) suggested a glaciomarine origin which may have been reworked by turbiditic redeposition.

Laminated mudstone facies

This facies is well seen in Pemali open pit mine. Vertically bedded, altered mudstone with thin limonitised layers along the Puding-Mentok road are also thought to be in this facies.

The unit comprises mudstones and minor intercalations of medium to thick, fine grained quartzose sandstones. Although the medium bedded sandstones seem to be laterally persistent, the thicker beds are lens-like bodies. The sandstone occasionally displays grading.

Mudstones comprise about 80 percent of the unit. They are dark grey and most of them are laminated with fine silt layers. Thin and parallel lenses of fine sandstones sometimes accompany the laminated mudstones. In most of the outcrops mudstones are deformed and altered and it is difficult to see primary structures. However, soft sediment deformed sructures can be seen in silicified boulders. Slump-like structures show eastward overturning.

Bedded-chert facies

Well exposed bedded cherts are seen in the Saing area near Tanah Bawah village. They are light grey to purplish and individual beds range from 1 cm to 5 cm with fine, parallel laminations. White dots of radiolarian tests are scattered in the chert beds and there is no indication of distortion to laminations because of them. The cherts are interbedded with thin to very thin red mudstones or cherty mudstones. Some ferruginous layers are interstratified in the cherts but it is uncertain whether they are primary or secondary.

Volcanic-chert facies

This facies has been described from the northwestern part of the island by Westerveld (1936). He mentioned the unit as Triassic, because at that time all the pre-Tertiary units on the island were thought to be Triassic. It comprises sills or stratified basic to intermediate volcanics and shales bearing radiolarian chert.

Five kilometres south of Pemali, there are several exposures of silicified tuff, chert and dark grey mudstones. The tuffs are light grey, fine to very fine grained and massive to thinly bedded. In some beds, orbicular to rod-like crystals are common. Dark grey mudstones interstratified with tuffs show both cross laminations and parallel laminations. The unit strikes 120° to 160° and dips steeply to the northeast or southwest.

Pyritic black shale-limestone facies

This facies is best seen in the Air Jongkong mines of the Koba district and in the southern part of the open pit mine at Pemali. Fusulinidae bearing limestones and pyritic mudstones, described by De Roever in 1951 from Air Durin village are included in this facies.

In the Koba area this facies comprises pyritic black shales, light grey shales, light grey siltstones/sandstones (tuffaceous ?), minor cherts and intercalated lenticular limestones. Pyritic black shales are massive in character but commonly display finely laminated silt layers and some fissile planes are graphitic. Pyrite is commonly present as thin layers parallel to the laminations but can also be disseminated. Black shales and light shales alternate but sometimes are also complexly intermingled. Light grey siltstones/sandstones (tuffaceous ?) intercalated in the unit are commonly highly altered. They rest sharply on the black shales or on light shales and sometimes contain elongated quartz pebbles at the base. Cherts in this unit are grey to cream and thin to medium bedded. Lenticular limestones are intercalated in the unit. They are usually silicified calcarenites. Individual beds are thin to medium bedded and tens of metres thick.

In Pemali area the unit is highly altered and deformed. Most of the pyrites from the black shales are leached out. Light grey siltstones/sandstones (tuffaceous ?) are sometimes gritty, graded and commonly contain feldspar fragments. To the south, some marbles and probable wollastonite-tremolite schists (reportedly serpentinite) are being found by the present drilling programme.

TEMPILANG SANDSTONE

This is predominantly a sandstone unit and can be clearly distinguished on aerial photographs by its relatively coarse texture and broadly folded structure. According to field studies, the unit comprises:

- a thickly bedded sandstone facies; and
- an alternating sandstone-mudstone facies.

Alternating sandstone-mudstone facies

This is well exposed in Mine No. 10 near Tempilang village. Westerveld (1936) also reported this facies from the Jebus area. It is represented by laterally persistent, monotonous alternations of sandstones and mudstones. Sandstones are fine-grained, well rounded, well sorted and feldspathic. They are white when fresh, about 25 cm to 3 metres thick, and both tops and bottoms are sharp. In thicker sandstone beds, thin mudstone lenses are generally present.

Mudstones are grey when fresh and reddish when weathered. They are 15 cm to 2 metres thick and mostly structureless. In some cases, thin bands of fossiliferous light grey mudstone (about 5 to 10 cm thick) are intercalated.

Thickly bedded sandstone facies

This facies is widely represented within the unit. It is well exposed at Gunung Pandan in the Tempilang area, at the coast of Pangkalpinang, Penyak and Batubetumbang, and Bukit Pelawan in the Koba area.

Sandstones are several metres to tens of metres thick. The thicker sandstone beds are frequently cross-bedded or show wavy laminations: dewatering structures are occasionally seen. Medium to thin mudstones occur as intercalations within the sandstone. In thicker sandstone beds, lens-like pebbly layers contain quartz, chert, silicified mudstone and quartzite pebbles measuring from 0.5 cm to 2 cm in diameter.

Intercalated mudstones are from 1 cm to metres thick. In some cases, transition beds, represented by composite sandstone/mudstone interstratified bodies (1 to several metres thick) occur.

FAN FORMATION

This formation is poorly exposed on the island. It is rarely seen and then only at protected places, such as between alluvial deposits and the pre-Tertiary units, when uncovered by recent mining. It is best seen at Mine No. 25 of the Pangkalpinang district.

This is a well indurated boulder-conglomerate unit, cemented by ferruginous material, with thin to medium bedded lenticular intercalated sandstone. The rounded to subangular pebbles and boulders are derived from underlying units. The major sedimentary structure of the unit is large scale trough cross-bedding.

RANGGAM GROUP

The Tertiary-Quaternary geology of the island has been well described in various publications. The present paper regroups these lithostratigraphic units into a single major one, informally named the Ranggam Group. There are two tentative units in the Group, namely:

Residual Gravel; and
Ranggam Formation.

Ranggam Formation

This unit was firstly described by Osberger (1965). Its type locality is at Ranggam village in northwest Bangka. It is seen along the coasts of the Island, mainly in small strips, but is also found far inland at open pit mines. The unit is sometimes referred to as the "Raya beds" and its off-shore equivalents are the Older Sedimentary Cover and the Alluvial Complex described by Aleva (1973).

The formation is a subhorizontal, sandy unit which shows an upward fining trend. There are two distinct facies: the lower part is a probable braided fluviatile facies represented by a massive (about 15 metres or more) gritty sandstones, locally with pebbly layers, passing upward into medium grained to fine sandstone. Medium bedded light grey mudstones are occasionally present as lenticules in the fine sandstones. The principal sedimentary structure in the sandstones is trough cross-bedding and pebble size mudstone balls are frequently present in the sandstones. In most cases, the uppermost part of the unit is covered by about 1 meter of light grey mudstone.

The upper part is a probable meandering fluviatile facies represented by similar fining-upwards band such as coarse sandstone-fine sandstone-mudstone unit, but individual beds are relatively thinner than the underlying unit. Major internal sedimentary structures in the sandstones are trough cross-bedding and plannar cross-bedding. The equivalent unit in the off-shore areas shows frequent valley incisions into the underlying beds and Aleva (1973) called it the "*Alluvial Complex*".

Residual Gravel

This is economically the most important unit on the island as a bearer of tin and is locally called "*Kaksa, Kulit* or *Krikil*". However, the term "*Kaksa*" is also used for the water-lain deposits (Adam, 1932; Adam, 1933; Krol, 1960; Osberger, 1965).

The Residual Gravel rests directly on weathered pre-Tertiary bedrock or on Ranggam Formation. It is about 0.01 to 2 metres thick and with angular to sub-angular components in both the coarse and fine fractions. In general, the coarser components reflect the underlying lithology. Fossils found in the unit are of continental origin, e.g. fossil fruits, wood and molars of elephants. However, when less than 8 metres above sea level, it can also contain marine shells and has presumably been reworked during marine transgressions. The unit may be covered either by alluvial beds or by residual soil.

INTRUSIVE ROCK

There are two major and 13 minor plutons on Bangka (Figure 5). Initially, all plutonic rocks were called granites. After Aleva's work on the magmatic rocks of Belitung Island (Aleva, 1960), Osberger in 1965 tried to subdivide the plutonic rocks of Bangka into granite and non-granitic plutons.

In general, the plutonic rocks on the island are elongated in shape, trending E-W and can be distinguished into Biotite Granites and Hornblende-Biotite Granodiorites. Biotite Granites are rich in silica (average 71.78% SiO_2), coarse grained, commonly porphyrite and sometimes foliated. They are locally called "*Blue Granites*" and are high in concentration of trace elements such as Th and U and key elements such as F, K_2O, Li, Rb and W (Hellman, 1983). These factors plus some other major, minor and trace element analyses indicate that they are probably of "*S-type*" granites (Hellman, 1983; Soeria-Atonadja *et al.*, 1984; Cobbing and Mallick, 1984).

From the magnetic susceptibility measurements they correspond to the ilmenite series granites (Cobbing and Mallick, 1984). Hornblende-Biotite Granodiorites are, medium to coarse grained, sometimes porphyritic and usually non-foliated. Some of the major, minor and trace element analyses indicate that they are probably of "*I-type*" granites (Hellman, 1983; Cobbing and Mallick, 1984; Soeria-Atonadja *et al.*, 1984).

Besides the above mentioned plutons, there are some small bodies of fine grained leucocratic granites and very minor gabroic bodies. The fine grained leucocratic granites are situated near the Biotite Granite plutons along the north-south trending high-angle faults. They are clearly younger than the Biotite Granites and were possibly emplaced during the Upper Cretaceous while the north-south faults were active.

DISCUSSION

Depositional Environment, Age and Correlation

In the Pemali Group, the Pebbly Mudstone facies is thought to be reworked glaciomarine deposit; the Laminated Mudstone facies is attributed to deposition in a "*starved basin*" as indicated by its very low sandstone content and frequent occurrence of very thin, parallel, lenticular fine sandstones. The Bedded Cherts are thought to be deep marine pelagic deposits, as indicated by the regular bedded nature and the fine parallel interlaminations, and deposition of the Volcanic-Chert facies was clearly influenced by submarine volcanic activity. The Pyritic Black Shale-Limestone facies is thought to have been deposited in reducing environment not far from the volcanic source. The exact nature of relationship among these facies is now known but the likely depositional environment of the Pemali Group is lower continental slope to deep marine.

The parallel and laterally persistent bedding of the overlying Tempilang Sandstone suggests a turbidite-like deposition. Scarcity of fossils, absence of cross-bedding and the fine-grained nature of the sandstone suggest an environment away from the shore and not the shallower shore. However, the sharp boundaries at the top and bottom of the sandstone beds are suggestive of some prevailing sea floor currents. This feature and lack of typical turbidite structures, both suggest that the unit is a "*contourite*" (Bouma, 1979). The thickly bedded sandstones are probable channel deposits and the depositional environment of the Tempilang Sandstone should be sought in some basins at the upper to middle continental slope.

The Pemali Group is isoclinally folded whereas the Tempilang Sandstone is broadly folded. From palaeontological evidences, a Lower Permian age is assigned to the Black Shale-Limestone facies (De Roever, 1951) and a probable Permian age is assigned to the Bedded Chert facies (Lemigas Biostratigraphic Services Unit, pers. comm., 1983). Probable Upper Triassic (Norian ?) age is assigned to the phyllite, quartzite and conglomerate unit (De Neve, 1947) of the Tempilang Sandstone. In this case, a time gap or a possible unconformity is assumed between the two units.

The Pemali Group and Tempilang Sandstone excluding the Pebbly Mudstone facies could be correlated to the Upper Palaeozoic-Triassic unit of central Malaysia (north Pahang and south Kelantan) which was described by Richardson in 1947. The unit is not only similar in lithology and age but also in deformational style.

The Pebbly Mudstone on the other hand closely resembles the Mohorok Formation of north Sumatra (Page *et al.*, 1978; Cameron *et al.*, 1980), Singa Formation of west Malaysia (Gobbett *et al.*, 1973) and Phuket Group of Peninsular Thailand (Garson *et al.*, 1975) which are of Carboniferous to Lower Permian age.

The piedmont fan deposit of the Fan Formation unconformably overlies the Tempilang Sandstone and is itself unconformably overlain by the Upper Tertiary Ranggam Tertiary. The Fan Formation is therefore thought to be Lower Tertiary age.

No marine fossils are found in the Ranggam Formation. Lower part of the unit mainly comprises very thick sandstones to gritty sandstones with frequent gravel layers containing mud balls. This feature and the major sedimentary structure, such as trough cross-bedding, indicate the braided fluviatile nature of deposition. The upper part of the unit is clearly of meandering fluviatile facies and the significant feature in the unit is the frequent occurrences of peat lenses in the mudstones. A Miocene-Pliocene age has been determined for pollens from the lower Ranggam Formation (Batchelor, 1979).

The Residual Gravel is dated by wood fragments and vertebrate remain etc., as Middle-Upper Pleistocene and is thought to have been formed during successive interglacials. During those periods, extensive chemical weathering may have been taken place. Subsequently, the weathered material slumped and moved downslope. Differential movements and elutriation caused it to accumulate as gravel layers, some material being carried as far as the valley floors (Figure 4).

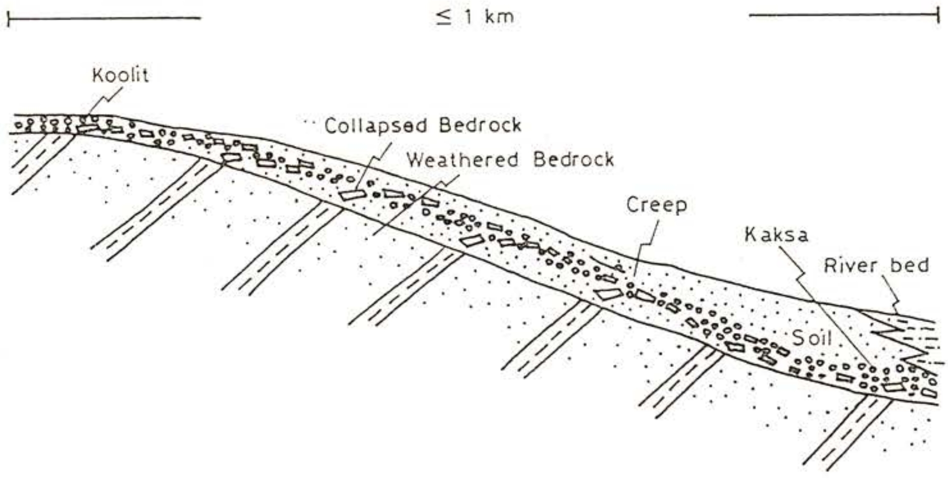

Fig. 4. Idealized section of residual gravel (Kaksa/Koolit).

STRUCTURE

Imbricate thrusting

The isoclinally folded Pemali Group and broadly folded Tempilang Sandstone occupy alternate east-trending structural units (Figure 5). On aerial photographs, northerly dipping Tempilang Sandstone can be seen to be overlain by Pemali Group along the Lumut-Air Durin valley. In the Air Durin area, a narrow elongate depression, trending northwest-southeast was described and attributed to limestone dissolution by De Roever (1951). However, absence of depressions from known limestone occurrences to the north suggests that the depression could be a fault line structure or a combined effect.

In the Saing area, an anticlinal structure of Tempilang Sandstone is cut and overlain by the Bedded Chert and Laminated Mudstone facies of the Pemali Group. This suggests over-thrusting of the Pemali Group over the Tempilang Sandstone. On the aerial photographs, a series of such parallel thrusts between the Pemali Group and the Tempilang Sandstone can be seen striking east-west to northwest-southeast. Plutons are elongated and parallel to these thrusts. The parallel nature of these geological features is probably of genetic significance rather than coincidental. There are two possibilities: either the plutons were carried up by thrusting or the plutons came up along the thrusts. However, not a single thrust intersects a pluton and in Koba area, the thrust is probably cut by the pluton. It suggests that thrusting probably preceded plutonism. This makes it likely that the plutons came up along the thrusts. Considering time and space, the thrusts clearly affected the Norian unit, whereas the plutonism at the Norian-Rhaetian boundary clearly affected the thrusts. This suggests that the thrusting is slightly older than or simultaneous with plutonism and that the plutons were probably generated during the latest phase of thrusting by partial melting at the root zone.

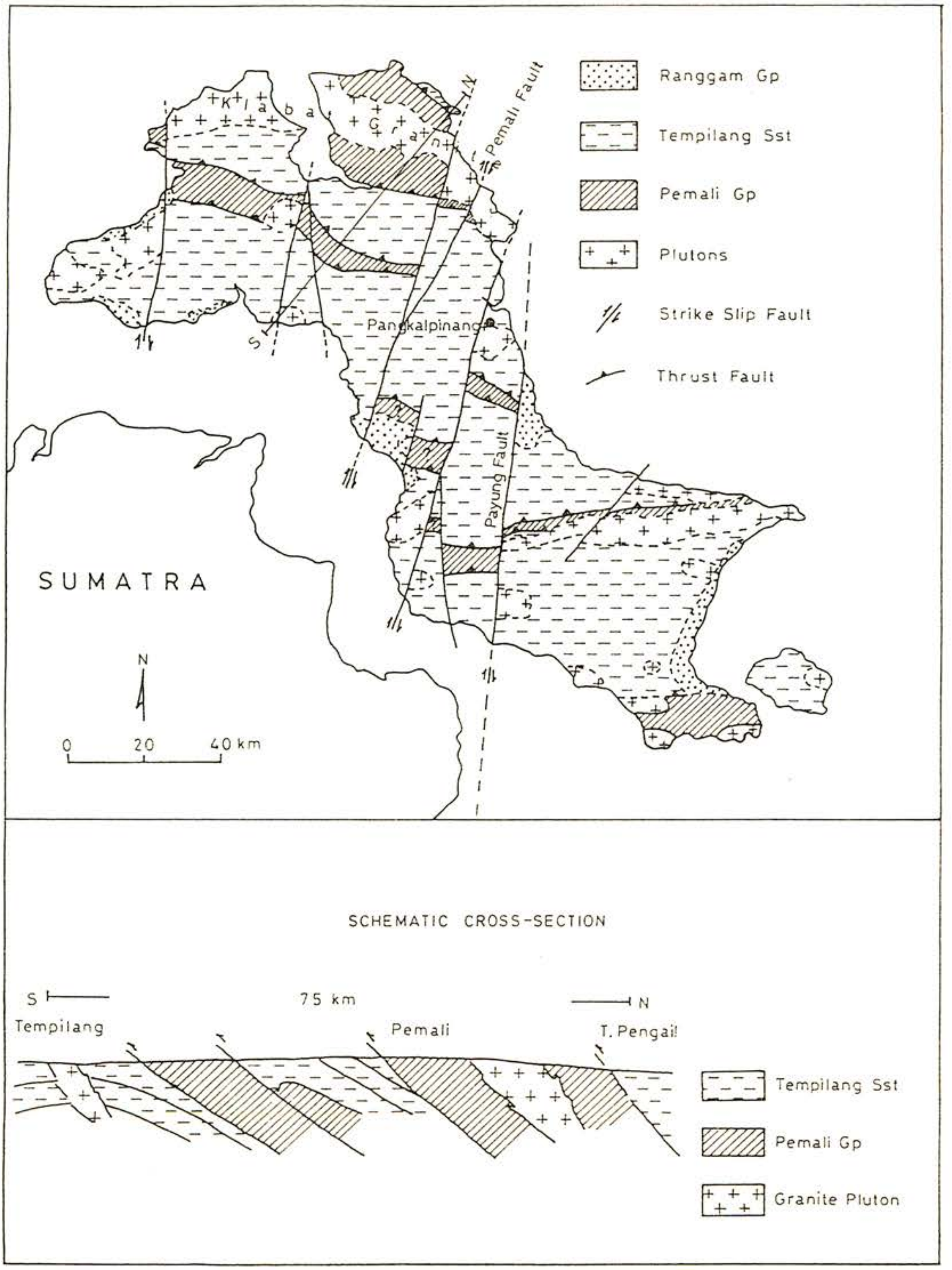

Fig. 5 Simplified geological map of Bangka Island.

Strike-slip faulting

The north-south trending Kelabat Fault was mentioned by Verbeek in 1897. Osberger (1965) thought that the fault had only a small vertical and horizontal displacement and was quite young. From SAR imagery, Cook (1979) interpreted some north-south trending lineaments. Wyntje (pers. comm., 1983) of P.T. Koba Tin mentioned a possible dextral movement along the central part of the island (after studying the limestone occurrences).

Since lithological units and thrusts can be recognised on the aerial photographs, it has become clear that several north-south faults cut the east-west to northwest-southeast striking lithological and structural units. Along those faults vertical movement is much less important than horizontal displacement which is of dextral nature (Figure 5).

There are at least 7 major north-south trending lineaments accompanied by minor splays. The net movement to the south of the easternmost block relative to the westernmost block is more than 80 kilometres. Maximum movement on an individual fault is seen along the Payung Fault, and possibly this is the one which extends along the east coast of south Sumatra.

Sunda land is thought to have been a stable land mass since Jurassic time without any major sedimentation taking place. In the Tertiary, conditions changed and sedimentation of thick terrestrial sequences occurred in certain zones — suggesting renewed uplift of the land mass and local subsidence. This uplift may be partly due to strike-slip faulting. When considering a major strike-slip fault zone, some portions of the blocks are being uplifted while others are subsiding, in accordance with the nature of horizontal movements. If a block is at the convergent zone it is being compressed and therefore uplifted, whereas at the divergent zone it is at the site of tension and thus subsidence (Crowell, 1974; Reading, 1981). Sedimentation will take place at the zone of subsidence due to a rapid erosion of the adjoining uplifted zone.

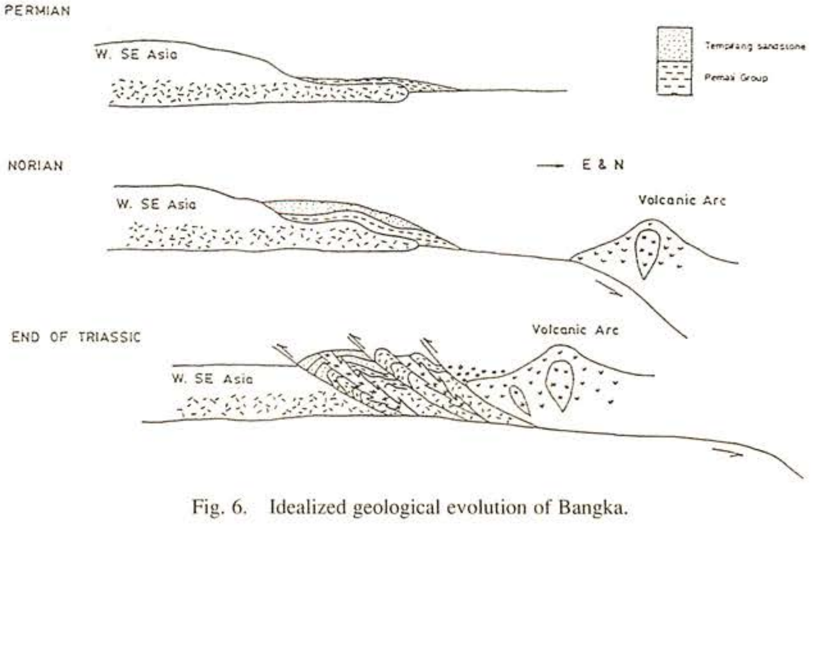

Fig. 6. Idealized geological evolution of Bangka.

The terrestrial sediments that were deposited during the Tertiary on Bangka and the surroundings are thus probably the result of strike-slip movement. If this is correct, the strike-slip faults were activated in the Late Mesozoic-Early Tertiary time.

CONCLUSIONS

Contrary to Osberger (1965) rock units on the island are distinguishable. According to present knowledge, the Permian Pemali Group is a deep marine, mud-rich facies that was probably deposited on subsided continental crust which may have been the western foreland area of the Southeast Asian continent. The sediment may have been partly folded during Lower Triassic. In Middle to Upper Triassic the Tempilang Sandstone was deposited in a relatively shallower facies above the Pemali Group.

The time span separating the Tempilang Sandstone, the thrusting and plutonism is small. Probably, at the end of Norian, the west Southeast Asian continent collided with volcanic arc to the east and to the north. Consequently, folding and thrusting took place in the foreland area. At the latest stage of collision, the granites were generated by partial melting at the root zone and intruded upwards. The gneissose structure of the plutons and the high initial ^{87}Sr/^{86}Sr ratio partly support this view. The island has been uplifted and eroded since the latest stage of the intrusion. In the Upper Cretaceous-Lower Tertiary, strike-slip faulting took place followed by terrestrial sedimentation in the zone of subsidence. During the Pleistocene, transgression-regression and deep chemical weathering prevailed and the Residual Gravel was formed. In sub-recent time the island has experienced several eustatic sea-level changes and some marine sedimentation took place on the lower part of the island (Figure 6).

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