

## **A summary of the Quaternary geology investigations in Seberang Prai, Pulau Pinang and Kuala Kurau**

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**Abstract:** Quaternary geological mapping in Seberang Prai, Penang Island and Kuala Kurau was started in February 1983 and completed in September 1988. It covers the lowlands and coastal areas of the Topographic Map Sheets 28, 39 and southern part of Sheet 16. A total of 12 deep boreholes and 288 shallow holes were drilled in the course of the investigation.

Generally the stratigraphy of the area is divided into Simpang Formation, Gula Formation and Beruas Formation. The lithology of the Simpang Formation is made up of gravel, sand, clay and locally silt and peat. It is accumulated or deposited in terrestrial environment by fluvial processes during the Pleistocene. The Gula Formation is subdivided into five members viz. the Bagan Datoh, Teluk Intan, Port Weld, Parit Buntar and Matang Gelugor. Generally the lithology consists of silt, clay, sand, sometimes gravel and peat and often contain shells. The environment of deposition is interpreted as shallow marine, estuarine and littoral and Holocene in age. The Beruas Formation constitutes sand, gravel, clay, silt and occasionally peat accumulated or deposited in terrestrial environment by fluvial processes during the Holocene.

**Abstrak:** Pemetaan geologi Kuaterner kawasan Seberang Prai, Pulau Pinang dan Kuala Kurau telah dimulakan pada Februari 1983. Ia meliputi kawasan pantai dan tanah-rendah peta topografi syit 28, 39 dan sebahagian syit 16. Di dalam penyiasatan ini sebanyak 12 lubang penggerudian dalam dan 288 penggerudian cetek telah dibuat.

Secara am stratigrafi kawasan kajian terbahagi kepada tiga unit lithostratigrafi iaitu Formasi Simpang, Formasi Gula dan Formasi Beruas. Lithologi Formasi Simpang adalah terdiri dari kelikir, pasir, tanah liat dan kadangkala lodak dan gambut. Ia telah diendapkan dipersekitaran terrestrial oleh proses fluvial dimasa Pleistosen. Formasi Gula pula boleh dibahagikan kepada beberapa ahli iaitu Ahli Bagan Datoh, Ahli Teluk Intan, Ahli Port Weld, Ahli Parit Buntar dan Ahli Matang Gelugor. Lithologinya terdiri dari lodak, tanah liat, pasir, kelikir dan juga gambut dan biasanya mengandungi fosil laut. Formasi Gula ditafsirkan telah diendapkan dipersekitaran litoral, muara sungai dan laut cetek dan ia berusia Holosen. Formasi Beruas terdiri dari pasir, kelikir, tanah liat, lodak dan gambut telah diendapkan oleh proses sungai dipersekitaran terrestrial dan berusia Holosen.

## INTRODUCTION

The area mapped is covered by Peninsular Malaysia Topographic sheet numbers 28, 39 and part of Sheet 16, Series L 7010. It encompasses the lowlands and coastal areas of the states of Penang and north-western Perak from Sungai Muda in the north to Sungai Kelumpang in the south.

Systematic mapping of the Quaternary sediments in the area commenced in February 1983 and completed in September 1988. It was temporarily stopped for almost two years in 1984 and 1985 due to unavoidable circumstances.

This report briefly summarises the results and interpretation on the Quaternary geology of the area. A Quaternary geology map is presented in figure 1.

### Previous studies

Courtier (1962) discussed features of alluvial terraces found in the Seberang Prai area and further east. Later, Courtier (1974) compiled the geology and mineral resources of Seberang Prai and the neighbourhood of Kulim in Kedah. Ong (in manuscript) carried out studies on the geology, engineering geology and mineral resources of Penang Island.

## GENERAL GEOLOGY

### Pre-Quaternary geology

Basically the area is underlain by granite intrusives and sedimentary rocks of the Sungai Patani and Mahang Formations (Courtier, 1974). Outcrops of Mahang Formation, presumably of Lower Silurian constituting black shale and dark flaggy siliceous shale are found in the north-east of Pulau Aman and east of Bukit Guar, Ipoh. Rocks of the Sungai Patani Formation are exposed east of Butterworth at Bt. Gua Gempas, Bt. Toh Alang, Bt. Merah, Bt. Jelutong and surrounding small hills, in Pulau Aman and Pulau Kendi. They consist predominantly of argillaceous rock including red shale, siliceous shale, laminated shale, sandstone and chert. It was inferred to be of Carboniferous age by Courtier (1974). However, fossil evidence found by C.K. Burton (Jones *et al.*, 1966) indicated Lower Silurian, probably Llandovery.

Bukit Mertajam and other numerous isolated outlying hills to the west are generally made up of medium to coarse-grained porphyritic granite called the Kulim Granite by Courtier (1974). The granite of Penang island has been classified basically into 3 types (Kwan, 1984). Medium to coarse-grained, megacrystic muscovite-biotite granite make up the southern half of the island, coarse-grained megacrystic biotite referred to as the Bunga type in the north-eastern and southeastern portion, and medium to coarse-grained sparsely megacrystic biotite granite with traces of muscovite, referred to as the Ferringghi type is restricted in the northwestern part. Ong (in manuscript) has classified

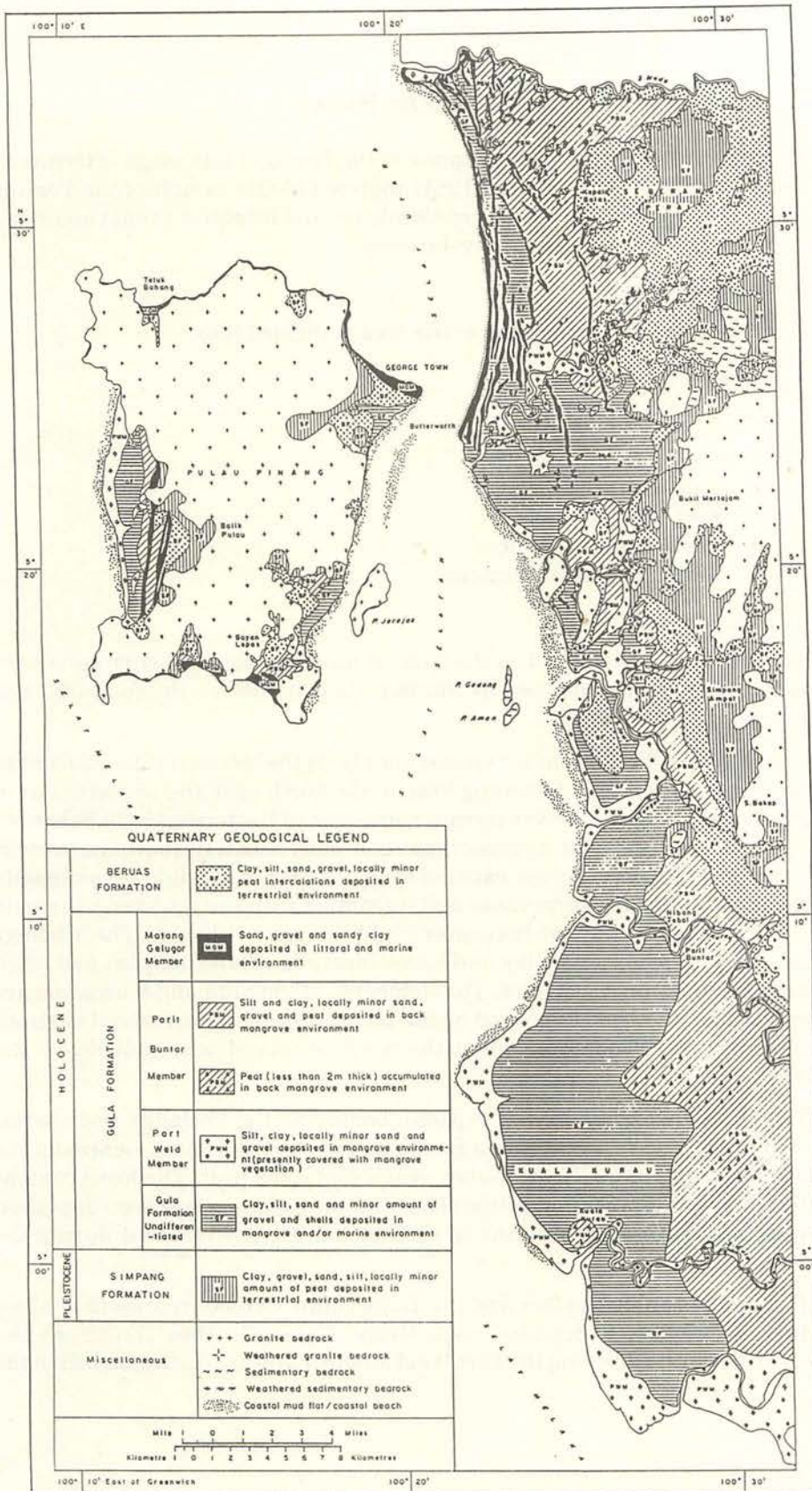


Figure 1: Quaternary geology map of Seberang Prai, Pulau Pinang and Kuala Kurau.

the granites in Penang Island to represent the first and late stage activities of the same magmatic event. Kwan (1984) analysed biotite samples from Penang Island and the results show two very closely related intrusive events occurring between the late Triassic and early Jurassic.

### **Quaternary geology**

The Quaternary stratigraphy of the area is divided into:

1. Simpang Formation
2. Gula Formation
  - a. Bagan Datoh Member
  - b. Teluk Intan Member
  - c. Port Weld Member
  - d. Parit Buntar Member
  - e. Matang Gelugor Member
3. Beruas Formation

These units are classified on the basis of lithology, age and environment of deposition as has been defined by Suntharalingam (1985), Bosch (1986) and Kamaludin (in manuscript).

The Simpang Formation is exposed mainly on the western side adjacent to the main range granite in Seberang Prai, in the north-east and western part of Penang Island, and as old river terrace north-east of Butterworth. In Seberang Prai it occupies an undulating topography generally 5 meters above the present mean sea-level. Where it is not exposed the formation is overlain by sediments of the Gula and Beruas Formations and its contact with the younger sediments is often marked by a paleosol horizon or slight change in lithology. The lithology is made up of gravel, sand, clay and lesser amounts of silt and peat and often shows a fining upward sequence. The sediments of the Simpang Formation are interpreted to have been deposited by fluvial processes in a terrestrial environment during the Pleistocene when the sea-level stand was well below the present.

The Gula Formation is well exposed, occupying the lowlands and coastal areas from Seberang Prai to Kuala Kurau and in Penang Island. Generally the lithology is made up of silt, sand, clay, gravel and some peat. The fossil content and lithology of the Gula Formation show that the sediment has been deposited in the littoral zone and estuarine to shallow marine environment during the Holocene.

The Bagan Datoh Member and the Teluk Intan Member represent shallow marine and estuarine deposits respectively. Generally they constitute the deeper sediment underlying the Port Weld Member and are distinguished in the

Butterworth area, Kuala Kurau and Balik Pulau on Penang Island. The marine sediments in these areas are generally more than 10 metres thick. The Port Weld Member represents the mangrove sediments, often with plant remains, and are well exposed around Butterworth, Kuala Kurau, Balik Pulau and south of George Town. The Parit Buntar Member is interpreted as the back mangrove sediment and forms the topmost strata in Parit Buntar and further south, south-west of Bukit Mertajam, and north of Butterworth. The Matang Gelugor Member represents the beach ridges (permatang) exposed as three tier sequence, the earliest near Kepala Batas and the youngest at Butterworth. The member is also exposed at George Town and Balik Pulau and is currently being formed north and south of the Penang Bridge in the South Channel.

The Beruas Formation underlies the area north-east of Butterworth, south of Bukit Mertajam and as granite wash deposit along the foothills south-east of Bukit Mertajam, Balik Pulau and Bayan Lepas. The formation is predominantly made up of clay with lesser amounts of sand, gravel, silt and peat deposited by fluvial processes during the Holocene.

## ECONOMIC GEOLOGY

### Tin

Placer tin is found only in small amounts in the area. Generally it occurs in sand and gravel layers ascribed to the Simpang Formation. The tin values ranges from  $0.01 \text{ kg/m}^3$  to  $0.06 \text{ kg/m}^3$  (0.076 k.p.c.y) and does not exceed  $0.13 \text{ kg/m}^3$  (0.16 k.p.c.y).

A total of 12 deepholes were made in the Seberang Prai area. Five boreholes BF1, BE2, BH3, BE9 and BH11 recorded trace values throughout their depths. Borehole BC8 showed cassiterite concentration less than  $0.02 \text{ kg/m}^3$  at depths of 45 m to 50 m. In borehole BA6, BA5, BB4, BH10 and BC7 cassiterite concentration ranges from  $0.01 \text{ kg/m}^3$  to  $0.13 \text{ kg/m}^3$ , generally at depths of 15 m to 20 m below ground surface.

### Clay

Continental clay deposits of fluvial origin are mainly found in the north-eastern part of the area, east of Kepala Batas and some occurrence south of Bukit Mertajam. Some of the clays tested is found to be suitable for the manufacture of bricks, subsoil pipes, roofing tiles and sanitary ware.

Marine clay is extensively found in the area especially around Kuala Kurau. Generally the clay blooms when fired above  $1000^\circ\text{C}$  or  $1100^\circ\text{C}$  and is recommended for use as light expanded concrete aggregates. However, some samples are suitable for the manufacture of roofing tiles.

## **Sand**

Sand mined from Sg. Muda is being used for construction purposes in the Butterworth area. The beach ridges at Butterworth and to the north could be a source of sand deposits. However, since Butterworth is a developing urban area, the limited suitable land available makes these narrow stretches of sand ridges more profitable for housing and settlement purposes. In addition, the western-most ridges along the coast form a natural barrier against sea-water incursion during spring tides.

## **Groundwater**

Potential groundwater aquifers could be found around Kepala Batas and further west at Kg. Sungai Lokan, Kg. Terus and Kg. Seberang Tasek (BC 8, BC 7, BH 10). From the boreholes data it is shown that these location contain significant gravel and sand layers between 12 meters to 27 meters in thickness. The quality of groundwater in these areas is yet to be determined. Ladang Bertam in Kepala Batas has been utilising groundwater to irrigate their oil palm and rubber plantation during the dry season.

## **CONCLUSION**

The Quaternary geology of Seberang Prai, Pulau Pinang and Kuala Kurau areas are subdivided into three lithostratigraphic units. The Simpang Formation represents the Pleistocene continental sediment, the Gula Formation constitutes the Holocene sediment deposited in the littoral to shallow marine environment while the Beruas Formation is made up of terrestrial sediments deposited during the Holocene. On the mainland Quaternary sediments are thickest along the western coastal areas and thin towards the hinterland.

Placer tin occurrence is rather limited and cassiterite concentration is low. Potential source of clay is in the north-eastern and central part of the area. Groundwater is also available in Seberang Prai.

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## **REFERENCES**

- BOSCH, J.H.A., 1986. Young Quaternary Sediments in the Coastal Plain of Southern Perak, Peninsular Malaysia. *Geology Survey Malaysia Quaternary Geology Report 1/86*, 83 pp.
- COURTIER, D.B., 1962. Note on terraces and other alluvial features in parts of Province Wellesley South Kedah and North Perak. *Geological Survey Professional paper E-62. 1-T*, 6 pp.

- COURTIER, D.B., 1974. Geology and Mineral Resources of the neighbourhood of Kulim, Kedah. *Geological Survey of Malaysia Map Bulletin 3*, 50 pp.
- JONES C.R., GOBBETT, D.J., and KOBAYASHI T., 1966. Summary of fossil record in Malaya and Singapore 1900-1965. *Geology and Palaeontology of Southeast Asia*, Vol. II, pp., 309-359.
- KAMALUDIN, B. H., 1989. Palynology of the lowland Seberang Prai and Kuala Kurau Areas north-west Peninsular Malaysia. *Geol. Soc. M'sia Bulletin 23*, 199-215.
- KAMALUDIN, B. H., 1989. Significance of Palynology in Late Quaternary sediments in Peninsular Malaysia. *Geo. Soc. M'sia Bulletin 24*, 57-66.
- KWAN, T.S., 1984. A note on some K/Ar ages of biotites from the granites of Penang Island, West Malaysia. *Schweiz. mineral. petrogr. Mitt.* 64, pp. 273-279
- ONG W.S., (in manuscript). The Geology and Engineering Geology of Penang Island. Geological Survey of Malaysia District Memoir.
- SUNTHARALINGAM, T., AND TEOH, L.H., 1985. Quaternary Geology of the Coastal Plain of Taiping, Perak. *Geological Survey Malaysia Quaternary Geology Bulletin 1*, 64 pp.

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