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Characteristics of History, Morphology and Landform of the Dungun Area, Terengganu, Malaysia with Special Reference to Bukit Bauk

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Abstract: This study was carried out to determine geomorphology and geological features of the Bukit Bauk. Bukit Bauk is located in the Dungun District, Terengganu, between 4°36'10" to 4°53'02" N and 103°07'25" to 103°25'50" E. Fields data were provided during three days fieldwork, from 22 to 25 of May 2006. The topography of Dungun area is divided into three different morphologies; 40% of the area consist of lowland, swamps and other water bodies covered 20 and 40% of this area is high landform that underwent weathering from grade III to VI. Geology of Dungun consisted of granite, meta-sediments, especially schist, phyllite and slate and quaternary sediments. Based on joint measurement of granitic rock at the coastal area, at least three compressions ($P_1$to P_3) were interpreted during the Late Paleozoic to Early Mesozoic deformation with directions of N 55° E; N 25° E and N 15° E. Environment of Bukit Bauk has been identified as vulnerable to the natural hazards such as flashfloods and landslides due to its position of being surrounded by swamps and coastal areas.

Key words: Bukit bauk, granitic rock, Late Paleozoic, weathering grade

INTRODUCTION

The East coast of Peninsula Malaysia is backed by Quaternary coastal plain where the highlands form major headlands and stretches of cliffs. Sand bars were distributed widely along the beach which was contributed by the larger rivers which is cut across the coast. Strong waves are prevalent during the North East monsoon. Raised beaches are a common feature along the Terengganu coast (included in the study area) as well as elsewhere along the East coast of Peninsular Malaysia. Historically, it's having been formed by a gradual isostatic uplift of the eastern coastline (MacDonald, 1968). The grade of sand is mainly medium to very coarse. The sand in Bris soils based on Hanafiah *et al.* (2004a) is composed mainly of quartz with minor amounts of heavy minerals.

Grain size analyses carried out on samples collected from different levels within the formation and location show that the sand is poorly sorted. Adam *et al.* (2005) added that Bris soil is marine origin, comprise of the seaward flanks of these flats, whose landward portion are commonly under freshwater swamp in which are deposited, sometime peat layers

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develop in these clays (Hanafiah *et al*., 2004b; Muslim *et al*., 2004). Bris soil based on Toriman *et al*. (2009) characterized by too sandy, weakly structured, nutrient deficient, having low water retention capacity, limited ability to support plant growth and having a relative high soil temperature.

Peat swamp forests in Malaysia are being extensively cleared for agriculture and other development projects (Gasim *et al*., 2007a). These land development projects may cause environmental damage to the peat swamp in adjacent areas by changing their hydrological characteristics. Activities such as logging, plantation and development in the long term lead to deterioration in the quality of peat swamp forest ecosystems. In the Middle East country such as Palestine, scenario of pollution is mainly due to agriculture and domestic activities, their water consumption derived from water spring and mainly polluted by heavy metals and fecal coliform (Daghrah, 2009).

Flashfloods occur especially in the swamp and lowland areas that are surrounded by the hilly region and they are caused by tidal surges from the South China Sea or from direct impact of the runoff phenomenon or from both of the above. Objectives of this study are to determine several factors that may stimulate the weathering process in the study area and to identify swamp distribution in the coastal area that may cause flashflood in the location between two rivers.

MATERIALS AND METHODS

Primary data on the geology and geomorphology of the study area was obtained from four days of fieldwork from the 22 to 25th May 2006. Field investigations included measurement of the amount of dip and the dip direction of the bedding, joints and faults were determined and analyzed in order to interpret their position in relation to the mechanism of weathering of metamorphic rocks. At least 100 readings of dip and direction of joints were measured for the exposed granitic body along the beach. A topographical map of the scale of 1:50,000 and a geological Brunton compass were used to facilitate the fieldwork.

The morphology of the study area was obtained from the topo map and all structural planes were measured using the geological compass. Geological characteristics such fault lines, rock boundaries, etc were based on aerial photographs. Structural data (joint planes) was plotted and interpreted using the Schmidt Net in order to obtain the relationship of the structural planes with the different directions of compression.

RESULTS AND DISCUSSION

Geomorphology of Dungun

Topographically, the morphology of Dungun consists 40% of the lowland is utilized for settlements and agricultural activities. Swamps and other water bodies such as rivers and floodplains cover 20% of the area, while the remaining 40% constitute forest reserves. Most of the highland areas are located in the central region and are characterized by irregular morphology, constituting granite and metamorphic rocks and it's covered by forests. The forest reserve comprises the hilly region which includes Bt. Bauk (472 m), Bt. Dal, Bt. Rengit (867 m), Bt. Belakang Parang (396 m) and Bt. Pak Belak (157 m). This hilly region and Dungun Town is located between Dungun River (North) and Paka River (South) and undulated coastal area in the Eastern part (Fig. 1). The scattered swamps and lowland areas which were identified by their undulating landform and low altitude ranges from 3 to 20 m ASL. The widest swamps area, consisting of the Pak Sabah and Tanah Hitam Swamps (128 km^2), surround the Sura Ridge, northeast of Bukit Bauk.

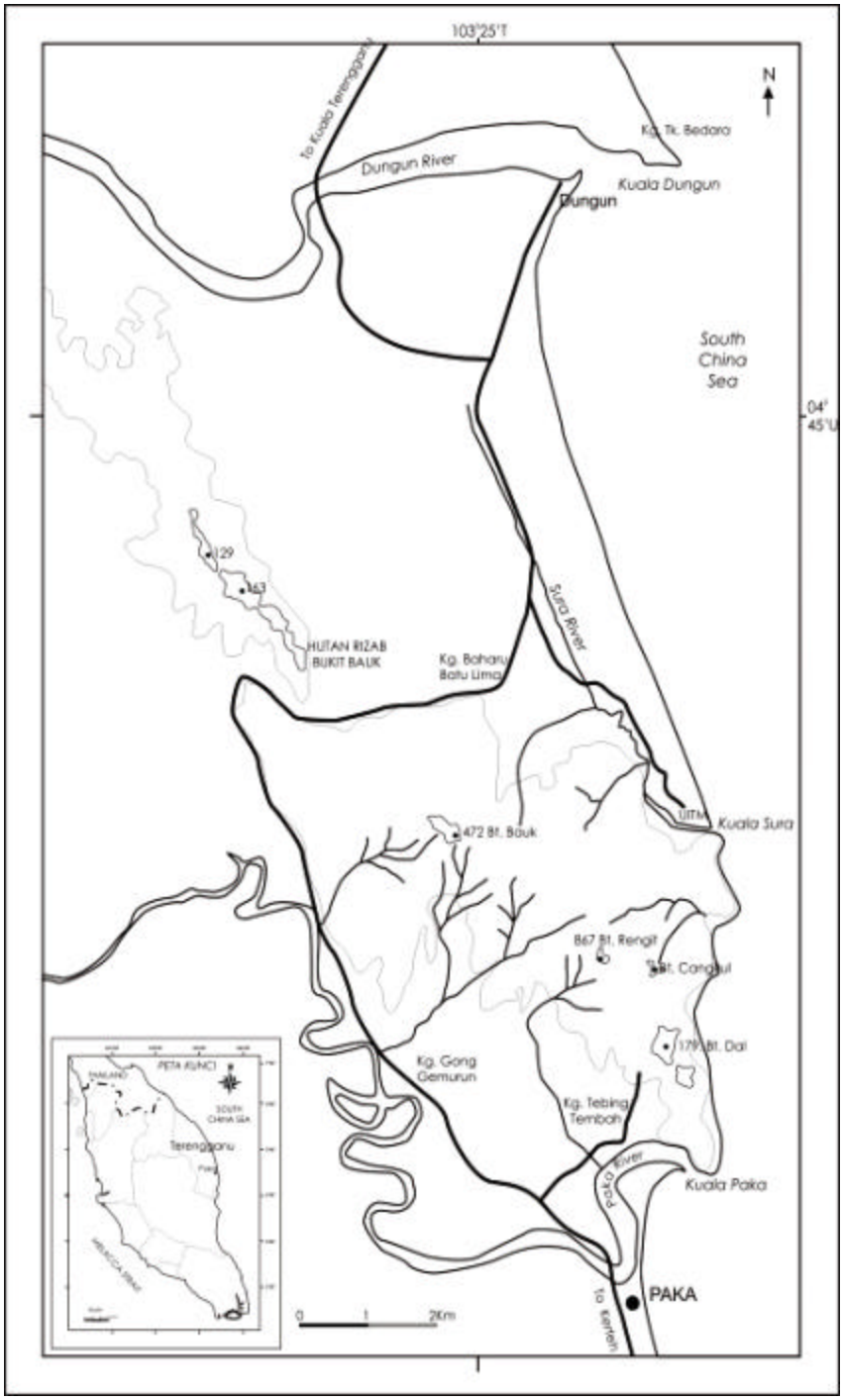

Fig. 1: Location of Bukit Bauk and the drainage system of the surrounding areas

Between these two swamps is the Sura ridges, ranging from 20 to 130 m, these ridges may be a continuation of the Bt. Bauk to the North. Weathered granite penetrates to a depth of 17 m to more than 34 m, while weathered phyllite and quartzite penetrate only a few meters (Fitch, 1952). The drainage system of Bukit Bauk is divided into two segments, the smaller rivers in the Northern slope that drain into the Sura River. The rivers from the Southern slope, namely the Gemuruh, Air hitam and Rengit Rivers drain into the Paka River. The Dungun River is the longest river in Dungun, flowing 110 km before reaching the South China Sea. There are some oxbow lake formed along the Paka River, but only sand bars are spotted along the Dungun River (Fig. 1).

Geology of Terengganu

Terengganu has a distribution of rocks exposed along the East coast from latitude 102°30'00" to 103°30'00" E and longitude 4°00'00" to 6°00'00" N. Rocks distribution of the Eastern Belt as divided by Yin (1985) fall into four groups:

- Carboniferous-Permian meta-sedimentary rocks
- Triassic Igneous rocks
- Jurassic-Cretaceous continental rocks
- Quaternary deposits (Fig. 2)

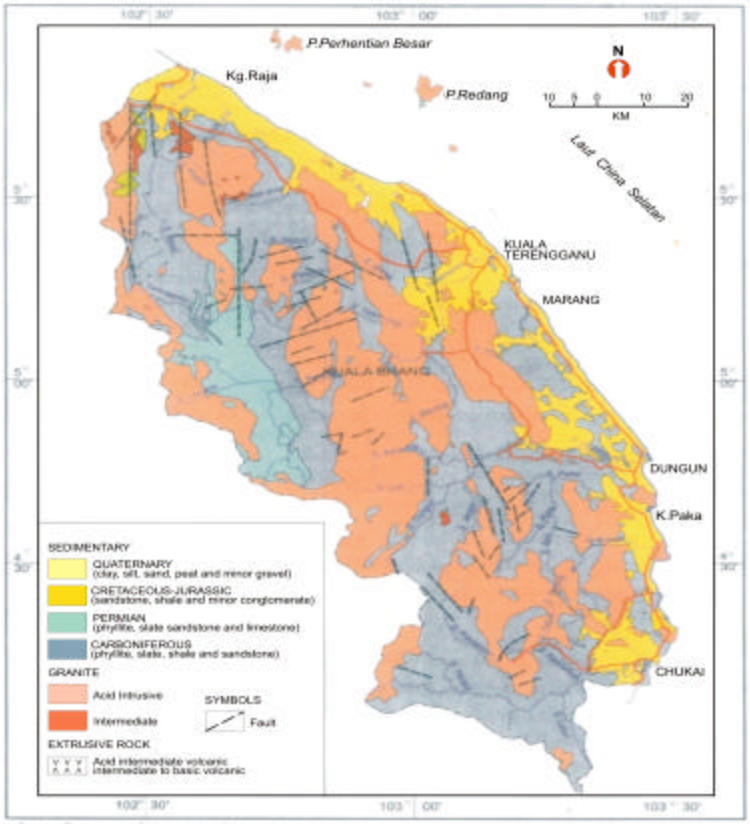

Fig. 2: General Geology of Terengganu (Yin, 1985)

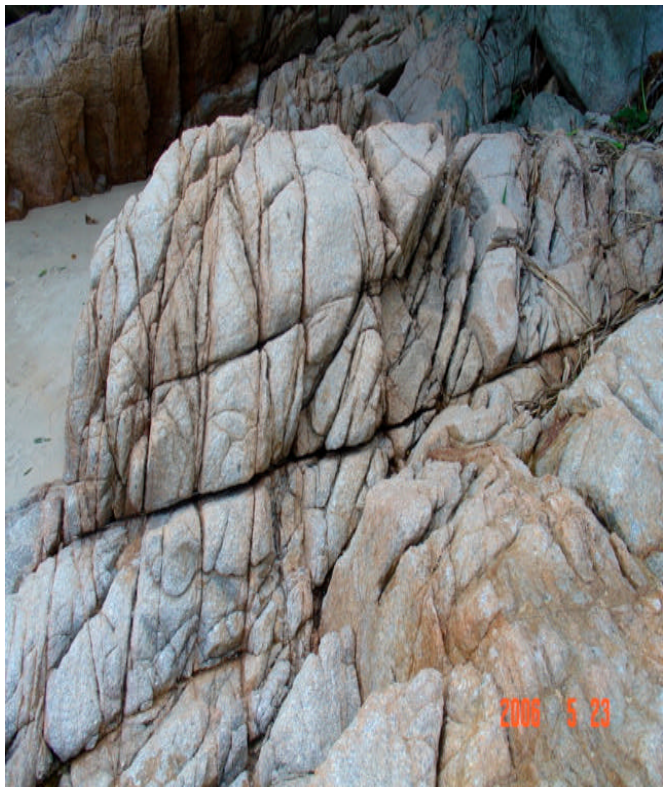

Fig. 3: Distribution of joints in granitic rock, Bt. Dal, Dungun

The study area, located in the South Eastern part of Terengganu, consisted of Carboniferous or older meta-sedimentary rocks (Chand, 1978; Abdullah, 2001), especially schist, phyllite and slate, surrounded by Early Triassic granite (Bignell and Snelling, 1977) and Quaternary sediments. These meta-sediments sequences exist and are distributed along the NNW axis of the Peninsular. Granite exposure along the beach in Bukit Dal was characterized with dense jointing caused by previous deformation (Fig. 3).

Structural Interpretation

The structural interpretation of the Dungun area discloses carbonaceous meta-sedimentary rocks that had been subjected to polyphase deformations. Abdullah (2006) added that structural studies indicated at least two phases of folding with fold axes trending toward North-Northwest and another N-S trending fold. The beds strike NNW and dip steeply toward ENE. It is also reported that a lateral fault system developed after brittle deformation occurred. The N-S fault zones are the oldest known fault zone in Terengganu, cutting across the young Cretaceous rocks and subsequently cut by the NNW trending fault zones (Tjia, 1998).

Structural interpretation in the form of a rosette diagram (Fig. 4) was carried out based on negative lineaments from the surrounding Bukit Bauk area (Table 1). Joint measurement of granitic rock at the coastal area, east of Bt. Dal showed that structural planes of joints were in different trends; horizontal, vertical and diagonal with strike orientation between N 345°

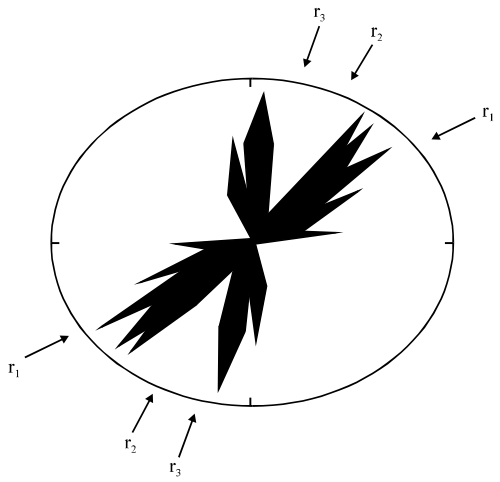

Fig. 4: Structural interpretation in the form of a rosette diagram

Table 1: Structural trend based on the rosette diagram

Compression direction (P)	Left Lateral Fault (SL)	Right Lateral Fault (SR)
N 55° E	N 85° E	N 25° E
N 25° E	N 65° E	N 05° E
N 15° E	N 45° E	N 345° E

to N 85° E. Three compressions with directions of N 55° E; N 25° E and N 15° E were interpreted in the study area. The direction N 55° E is considered the main regional compression because it was also recorded in Pulau Kapas (Gasim, 1988).

Structural distribution of Bukit Bauk is relatively complicated; this structural pattern can be observed in Fig. 5. From Fig. 5 can be seen that the geology of Bukit Bauk was initiated by the development of folding at the NNW axis due to NNE compression during the Late Paleozoic to Early Mesozoic deformation. The range of the compression based on the rosette diagram is from N 15° E to N 55° E (Table 1) and is more promising as the relationship between fold and joints/faults is positively related. After the first deformation, Bukit Bauk experienced another deformation which occurred during the Cretaceous period (Tjia, 1998) with compression direction N 25° E. This orogeny cut across the rocks and the fold axis by NNW trending lateral fault zones (Fig. 5). These lateral faults occurred in Bukit Bauk due to a series of compressions since the development of the fold. The orientation of each fault plane was determined with respect to the direction of compression (±30° to the P_1).

Weathering Process

Terengganu is located in a tropical zone and the weathering process constituted chemical and mechanical weathering. Weathering and erosion continued the breakdown of the rocks due to long exposure to the atmosphere and difference in pressure and temperature. Weathering agents such as rainwater, oxygen, carbon dioxide and plant decay acids have been identified as medium factors that generated depth to the weathering profile in Bukit Bauk. Temperature and soil moisture of the forest environment activated the weathering process. Based on weathering grades (IAEG, 1981), the landform of Bukit Bauk shows that it underwent weathering from grade III to VI (grade I is categorized as fresh rock and grade VI is soil). It appears that grade IV and V materials, brown in colour underlie the

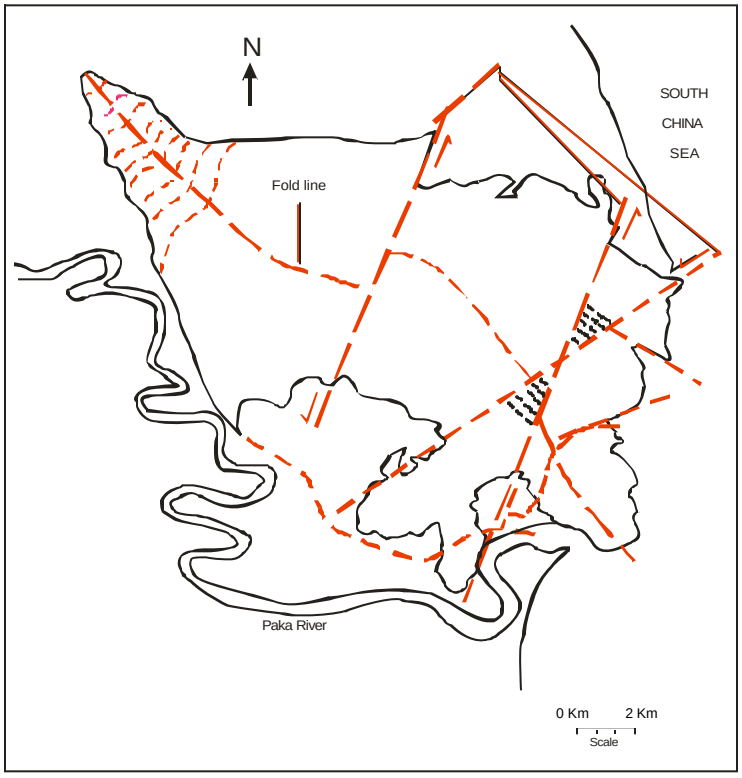

Fig. 5: Structural interpretation of the Bukit Bauk area

grade VI materials and cover the forest floor. Granitic rocks, deep beneath the surface, contain hornblende, biotite, quartz and feldspar minerals. The feldspar began weathering when the rock was exposed and then it broke down into kaolinite and dissolved into elements such as K, Na, Mg and Ca and finally it formed clay from reaction with water. The presence of groundwater is also considered an additional factor contributing to the weathering.

Flashfloods

The occurrence of flashfloods in Dungun was interpreted as due to a combination of physical factors such as elevation and its close proximity to the sea apart from heavy rainfall experienced during the monsoon period. More than 30 to 50% of Dungun has been categorized as low-lying coastal areas with an altitude of less than 200 m ASL and 30% of the area identified as vulnerable to flashfloods. Heavy rainfall during the Northeast monsoon between October and March results in severe floods almost every year. Normally, during the months of northeast monsoon (November and December), average monthly rainfall range from 250 to 900 mm and it would generate flashflood. Floods that affect the Dungun district are categorized as a coastal flooding. Flashfloods also coincide with the occurrence of high tides, which slow down the flow of river water into the sea. Flashfloods occur almost every year in Dungun when the water level of the Dungun and Paka Rivers rises a few meters above the danger level based on flood history from 2000 to 2004 (Gasim *et al*., 2007b).

CONCLUSIONS

The geological history of the eastern coast of Terengganu is beginning with deposition of sedimentary rocks since Late Paleozoic, followed by granitic intrusion on the Early Triassic. Weathering process taken place after rocks exposure and followed by erosion and beaches formation during Post-Pleistocene. These processes were possibly responsible for the exposure of the morphology or beach ridges along the East coast of Peninsular Malaysia during this time. The settlement in the areas surrounding Bukit Bauk has been vulnerable to the occurrence of natural hazards such as flashfloods and landslides due to its position of being surrounded by swamps and coastal areas and only if the forest authority really preserves the forests in the areas surrounding Bukit Bauk, could be minimized the hazard.

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