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CONSERVATION GEOLOGY OF LANGKAWI ISLANDS

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SUMMARY

Research on the geological resources and landscapes of Langkawi islands has revealed the great geotourism potential of the island system. Comprising the oldest rocks and the most complete Paleozoic - Mesozoic sequence of sedimentary formations, the Langkawi rocks tell the story of the beginning of the Malaysian Land. Diverse scientific records, fossil beds, geological structure and outstanding landforms further make Langkawi a living museum where visitors are able to directly experience a potential natural world heritage site. Conservation of geosites and geotopes are absolutely necessary, in the form of geological park, geological monument, protected site and beautiful landscape, to sustain its ecotourism activities.

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GEOTOURISM OF LANGKAWI

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SUMMARY

Langkawi is one of the most beautiful islands group in Malaysia. Apart from having a distinct and unique morphological feature such as Machinchang ridge and karstic morphology in the limestone area, there are a lot of other interesting geological features. Among those are located in the already popular tourist sites, such as Pantai Pasir Hitam, Telaga Tujuh, Pantai Pasir Tengkorak, Telaga Air Hangat, Gunung Raya and Tasik Dayang Bunting. The geological features of those sites are described and is proposed to be made available in the pamphlet forms or placed at sites as geoinformation boards to increase the tourist geological understanding when they visit those sites. Apart from that, there are also many localities with interesting, as well as unique or rare geological features witch are not easily found in other parts of Malaysia. All these localities are of very high potential to be promoted as new geotourism spots. Since the Langkawi Islands is very rich in either already popular or potential geotourism localities, a number of geotourism trails is proposed. Each trail could be reach either by land or sea and may be visited in one day trip.

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GEOTOURISM POTENTIAL AT NATIONAL PARKS

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SUMMARY

Since the Taman Negara (National Park) is managed by PERHILITAN (the Department of Wildlife and National Park), it is not surprisingly that their conservation and ecotourism activities are focused more towards the biological eco-system. Though not many people may realize, it is the facts from its physical ecosystem (in which geology is concerned), which helped Taman Negara to be established as one of the oldest legendary forest in the world. Unfortunately, the geological history alone is not sufficient in attracting visitors to appreciate other rocks and landscape of Taman Negara. Available geological information show that the Taman Negara possessed many interesting geological features to offer its visitors. Among others are the proud peak of Gunung Tahan, Gunung Gagau and its plateau, Gunung Tangga Dua Belas - Gunung Gedung ridge, limestone towers and caves such as Bukit Batu Besar, Gua Telinga, Gua Luas, Gua Daun Menari, Bukit Biwa, Gua Peningat and many others. The work of rivers had etched and carved the landscape of Taman Negara forming some magnificent rapids and waterfalls, such as Lata Berkoh, Air Terjun Empat Tingkat and many others. Fossils of ancient living forms preserved naturally in sedimentary rocks of Taman Negara for million of years are so valuable. Among the oldest one are those fauna from Bukit Biwa and Sungai Sepia, aged as old as 265-270 m.a., while flora fossils from Sungai Pertang indicated that the present landforms of Taman Negara is a result of a more than 150 m.a of natural landscaping process. Apart from all these, the Taman Negara is also not deprived of beautiful minerals and crystals one should admire. All these data and many other unexplored geological heritage show that the geotourism concept has got very strong ground and ever ready to be developed in our beloved Taman Negara.

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GEOTOURISM OF THE KINABALU PARK

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SUMMARY

Geotourism is a georesource based special activity to explore, appreciate and learn about the beauty of nature focused on geological experience. Geotourism involves visiting geosites, a single or group of geological sites in the field, which has a high degree of heritage, scientific, aesthetic and/or recreation value. Geosites are identified and developed as special destinations for visitors. Most of the geosites for geotourism activities in Kinabalu Park are located along the trail and the main road surrounding the Kinabalu Park Headquarters, Timpohon Gate - Panar Laban trail, Panar Laban and the Kinabalu Plateau area. These selected locations consist of more than one geosites. Around the Kinabalu Park Headquarter the geosites include Kinabalu Parks Wood Fossil, Tenompok Interbeded Sediment, Liwagu Fault Zone, Liwagu Fault Block and the Liwagu Cataclastic Unit. At the Timpohon Gate - Panar Laban trail, geosites such as the Timpohon Gate Sedimentary Rock, Carson Fall, LayangLayang Peridotite, Mempening Metamorphic Rock and Villosa Porphiritic Granodiorite have been identified. In the Panar Laban area, the geosites include the Laban Rata Til Deposits and Gunting Lagadan Roche Moutonnee. Geosites identified in the Kinabalu Plateau area are Lows Peak, Lows Cirque, St. John U Gully, Western Plateau Hanging Valley, Lows Gully, South Peak Dyke, Ugly Sister Xenolith and Sayat-Sayat Fault. Each geosites has its own geological history and this information contributes to the overall study of geological evolution in the Kinabalu Park area. Several basic infrastructures such as trails, signboards and guide maps have been prepared and produced to enhance geotourism activity in the Kinabalu Park area.

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FRAMEWORK OF CONSERVATION AND TOURISM GEOLOGY FOR DEVELOPMENT FOR GEOSCIENCE INFORMATION

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SUMMARY

Geological conservation is an initiative to maintain physical natural resources which have intrinsic, heritage, aesthetic or recreational values to be admired by the present and future generations. Meanwhile geotourism is a special tourism activity that is being developed from the geological conservation efforts for the nature to be experienced and learned based on its geological resources. Apart from that, both activities are potential to expand geoscience information collectively by revaluating the existing and new geological resources. Hence, in order to develop the geological conservation and implementation of geotourism more systematically, specific frameworks are presented as a guideline. Both frameworks have similarity because they intersect in terms of approaches. The framework of geological conservation consists of three major stages namely inventory, classification and utilization while the framework of tourism geology covers inventory, evolution and utilization. Both frameworks can strengthened each other by establishing conservation plan and geotourism plan.

6

THE BLACK SAND OF LANGKAWI ISLANDS

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SUMMARY

The black sand of Langkawi Island is a tourist attraction due to its mysterious black colour. The objective of this work is to study the mineralogy of the black sand of the Langkawi Island and thus identify the cause of the black colour of the sand. The study is made by separating the heavy minerals after quartz was separated out, by using the Frantz Isodynamic magnetic separator, followed by microscopic examination and X-ray diffraction. The result shows that in almost all samples the black mineral is tourmaline. Some ilmenite is also observed, i. e. in the sample from Teluk Burau and the sample from Pantai Pasir Hitam taken at high water level, but this mineral is not the major black mineral and is thus a minor contributor to the black colour of the sand.

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THE HOLOSENE SEA LEVEL AT TANJUNG DENDANG ISLANDS: MALAYSIAN GEOLOGICAL HERITAGE

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SUMMARY

Three assemblages of fossils that consist of various seashells were discovered at an ancient wave-cut notch, in Pulau Tanjung Dendang, Langkawi. The first assemblage comprises shells of *Saccostrea cucullata* fossil encrusted on the wall of the notch in growth position. The second assemblage is composed of fossils of Bivalvia, gastropods, barnacles and corals that are preserved and cemented underneath a limestone column. The third assemblage consists of shell fragments of Bivalvia and gastropods that are cemented onto the wall of the sea notch. Radiocarbon dating of *Saccostrea cucullata* indicates the age of 7,000 B.P. The occurrence of the seashells assemblage is interpreted that about 7,000 years ago the sea level could have reached 23 m above the present sea level.

8

STRUCTURAL GEOLOGY OF SETUL FORMATION AT LANGKAWI ISLANDS

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SUMMARY

The rocks of Setul Formation are commonly found in the eastern part of Pulau Langkawi. Based on the change in strikes and dips of the bedding plane of the limestone, it is interpreted that the Setul Formation was folded regionally. The fold axes of the regional folds trend almost in NNE direction in the southern parts, North-South in the middle and NNE in the northern parts of the area. Field observations indicate that the structures in the detrital members of the formation are more complicated than in the limestone. The limestone of this formation was faulted as well as folded. The well-known Kisap Thrust Fault was interpreted to play very important role in controlling the rock distributions in this area, which separates the Lower Palaeozoic from the Upper Palaeozoic rocks. In the north-eastern part of Langkawi main island, high angle reverse faults are very common and across Selat Peluru which is aligned almost in 310 to 320E, these faults are displaced left-laterally. At several localities, medium scale reverse to thrust faults, which are separating the limestone and the detrital rocks of this formation, are observed.

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GEOMORPHOLOGY OF DAYANG BUNTING ISLANDS, TUBA ISLANDS AND SINGA BESAR ISLANDS, LANGKAWI

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SUMMARY

Geomorphological maps contain information about landforms of an area, which are useful for certain applications. Aerial photograph are the main source of information in this geomorphological mapping work, carried out in Pulau Dayang Bunting, Pulau Tuba and Pulau Singa Besar of the Langkawi Islands. Geomorphological units are classified based on the degree of steepness and fall into the categories of flat to gently sloping terrain, moderately sloping terrain or extremely steep terrain. These units are also classified based on the morphogenesis of the landform such as karstic, marine, fluvial or denudational origins. Sixteen geomorphological units have been recognised and mapped in this study. The dominant unit in Pulau Dayang Bunting is of karstic origin that includes karst hill and mountains, star karst zones, conical karst zones, tower karst hill, sinkhole, karst alluvial plains and karst marginal plains. There are also several geomorphological units that occur in the island which are of non-karstic origin such as denudational hills, denudational mountains, sandy beaches and vegetated tidal flats. The geomorphological units in Pulau Tuba consist of denudational hills, talus, sandy beaches, marine terraces, vegetated tidal flats, non-vegetated tidal flats, karstic denudational slopes, tower karst hills and sinkholes. The dominant geomorphological unit in Pulau Singa Besar is of denudational origin, which consists of denudation hills and denudation valleys. Other geomorphological units, which occur in the island, are sandy beaches, vegetated tidal flats and tower karst. hills. This study has produced a geomorphological map of the study area.

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TERRESTRIAL SEDIMENTS AT NATIONAL PARKS

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SUMMARY

Taman Negara comprised of sedimentary, metamorphic and igneous rocks. Jurassic-Cretaceous (I00-180 million years old) continental sedimentary rock built the Gunung Tahan, which is the highest mountain in Peninsular Malaysia. These sedimentary rocks can be divided to three units, the Tembeling Group, Gagau Group and Koh Formation. These rock units were deposited at the same time, but in the different basin.

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GEOLOGICAL TRAIL OF KUALA CHICHIR-GUNUNG GAGAU, TAMAN NEGARA

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SUMMARY

Taman Negara trail between Kuala Chichir and Gunung Gagau exposed several different lithologic units. Among them are fine-grained sedimentary rocks of Permian age (250-290 m.a.) and coarse-grained sedimentary rocks of Jurassic-Cretaceous age (100-180 m.a.) known as the Gagau Group. The Permian sedimentary rocks are mainly made of massive mudstone and siltstone deposited in shallow marine environment. The Jurassic-Cretaceous rocks are continental deposits, made of thickly bedded to massive sandstone exhibiting well defined cross-bedding and erosional base or channel structures. The sandstone is a clean sandstone derived from older sandy sedimentary rock as well as granitic rock. The Gagau Group is very competent towards erosion and has undergone very little tectonic deformation. As a result, this rock formed homoclinal ridges with Gagau plateau as part of this unique geomorphic feature.

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GEOMORPHOLOGY AND GEOLOGY OF BUKIT BATU BESAR, TAMAN NEGARA, PAHANG

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SUMMARY

Besides being a sanctuary for wild animal such as tigers, panthers, antelopes and elephants, Bukit Batu Besar that is situated at the upper reaches of Sungai Keniyam Kecil is also unique for its geomorphology and geology. Bukit Batu Besar is the largest and tallest limestone hill within the chain of NNWSSE striking limestone hills, including among others the Gua Luas, Gua Daun Menari and Gua Kepayang. The western part of Bukit Batu Besar is mainly made of massive limestone, while the eastern part of it is made of thickly bedded limestone interbedded with sandy limestone. The estimated thickness of the limestone is about 570 m. The limestone bedding is steeply dipping to the ENE. Bukit Batu Besar limestone overlain older volcanic rocks in the west, and it are overlain by conglomerate - sandstone unit in the east. The true nature of the boundaries are not exactly known. The limestone ranges in composition mainly from grain stone to pack stone and can be interpreted as of shallow marine sediment. The limestone is in places quite fossiliferous yielding poorly preserved microfossils including algae such as *Tubiphytes* sp., *Thaumatoporella* sp. and *Solenopora* sp. and rare foraminifera such as *Glomospira* sp. and *Endothyra* sp. of probably Triassic age. Karst geomorphic features are common in Bukit Batu Besar including caves, stalactites and stalagmites of various shape and size.

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MENGGIS OPHIOLITE: GEOLOGICAL HERITAGE OF KINABALU PARK

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SUMMARY

Geological mapping in the Kinabalu Park revealed the presence of ophiolite associations at Menggis. The rocks are well exposed along Sg. Kepuakan and Sg. Kikulat. The ophiolite associations, consists of red mudstone, red chert, turbidite and peridotite, which formed part of the Sabah ophiolitic complex . These rock types are separated from each other by thrust faults, which represent an unconformity. The peridotite represent the ancient oceanic crust. Collision between oceanic plate and continental crust near the subduction zone is believed to have formed the thrust faults. The ophiolitic rocks were scraped off by the collision and faulting events. The Menggis ophiolite has a high degree of scientific value. This particular rock is very rare in Malaysia and only found in Borneo Island especially in Sabah, and Menggis is the only location of ophiolitic rocks in Kinabalu Park. The scientific value and rarity of the ophiolite associations in Menggis is one of the geological heritages of Kinabalu Park that can enhance geotourism.

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PINOSOUK GARVEL: MALAYSIAN GEOLOGICAL HERITAGE RECORD OF TILLOID SEDIMENT

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SUMMARY

Kundasang-Ranau area is the only geosite in Malaysia, which shows tilloid deposition process in the tropic. The Pinausok Gravel deposit is deposited during the Late Pleistocene, approximately 37,000 years BP or older based on the radiocarbon dating of the wood fossils. It consists of two units; Lower Unit and Upper Unit that shows two phases of sedimentation. The first phase is caused by glaciation and the later by ancient mud flow. Based on petrographic study, the sources of Pinausok Gravel deposits are tertiary sediments namely Trusmadi Formation and Crocker Formation. Granodiorite materials derived from the emplacement of Mount Kinabalu while the ultrabasic boulders came from the ultrabasic rock which formed border between the rocks of granitoid and tertiary sediments around Mount Kinabalu. Conservation should be commenced by declaring this area as protected landscape because of its scientific and aesthetic values. This natural zone should be supervised by an organisation such as Local Councilor Kinabalu Park. The development and agricultural activities could be done if all necessary steps are taken.

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THE GEOTOPE OF KLANG QUARTZ RIDGE, SELANGOR

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SUMMARY

The Klang Gates Quartz Ridge, which cuts across the northern part of the Federal Territory of Kuala Lumpur is the longest quartz ridge landscape in Malaysia. The ridge, composed of 100% quartz mineral, has a length of up to 14 km and a maximum width of nearly 200m. The quartz ridge, which in fills the Kuala Lumpur Fault zone has very high scientific and outstanding landscape values, making it suitable to be classified as a geotope. The Klang Gates Quartz Ridge is a natural heritage (geology and landscape) of national standing.

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ANCIENT OCEANIC CRUST AT BALIOJONG, TANDEK, KOTA MARUDU, SABAH

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SUMMARY

An ancient oceanic crust associated with sedimentary rocks is well exposed along Baliojong River in Tandek. The oceanic crust is made up of pillow basalt, dolerite and gabbro, whereas the sedimentary rocks consists of chert, mudstone and sandstone beds. This rock unit, with a thickness of more than 1 kilometer is folded and faulted forming several nearly vertical thrust sheets trending approximately North-South. Radiolarian fossils from chert beds suggest that the oceanic crust was formed around 90-120 million years ago. A sedimentary rock unit, the Crocker Formation overlies this ancient crust along one of the road here.

Manganese ore found associated with the chert beds was once mined in the early 1800 'so Relics left by the mining activity such as tunnels, metal buckets and rail tracks can be found along the river. The Baliojong River has cut into the rock unit producing numerous narrow gorges. In several sites, pillow basalt layers being more resistant to water flow erosion, has produced small-sized but beautiful waterfalls. Several small to medium-sized deep natural pools also occur along the river.

The presence of diverse rock types and its interesting river morphology makes Baliojong River an ideal site for studying oceanic crust formation and river system processes. Apart from being a potential geoscience research and education field site, the pristine condition of the river makes it an ideal site for recreation.

The potential of this natural heritage for ecotourism development is high. However, this potential could be threatened by uncontrolled development activities along the river. To ensure that this site is protected, it might be necessary to gazette part of the Baliojong River basin as a natural heritage. It is also necessary to carry out further study to determine the best method for its conservation and development.

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UNCORNFORMITY AT KAPAS ISLANDS: A GEOLOGICAL HERITAGE

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SUMMARY

In Pulau Kapas, there is an unconformity which is structural planar surface separating younger rock sequence of Kapas Conglomerate above, from older Permo-Carboniferous rock sequence below, Unconformity is an important geological feature because it can explain the geological history of these sequences. The Kapas Unconformity is very interesting and easy to visit. This feature not only should be preserve but could tell the people about the geological history of the Pulau Kapas.

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REDANG ISLANDS PLANT FOSSIL HERITAGE

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SUMMARY

A fossil is a remain or a trace of ancient living organism preserved in sedimentary rocks. In Malaysia, a lot of Cenozoic (less than 65 million years old) plant fossil was found, but not for the older fossils. In Pulau Redang, a few fossil localities were founded, and contain among the oldest plant fossils in Malaysia. This plant remains believe to be Late Permian in age. Since this plant fossil is very significant for geology, so these fossil localities should be preserved.