1
CONSERVATION GEOLOGY : RESEARCH AND DEVELOPMENT NEEDS IN MALAYSIA

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SUMMARY

Conservation geology is not merely the preservation of geological heritage. Its philosophy embodies a rigorous study of intrinsic geological resources and their development. This pioneering research focuses on the development of the concepts, systematic and approaches to resource utilisation, which have been initiated through strategic alliances with the Langkawi Development Authority (LADA), Department of Wildlife and National Parks (PERHILITAN) and Sabah Parks.

2
THE STATUS OF GEOLOGICAL RESOURCES CONVERSATION IN MALAYSIA

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SUMMARY

This research is aimed to review the evolution of the activity of geological resource conservation and ecotourism as well as to document the secondary data from the study areas, which are Langkawi Islands, Sabah Parks and National Park. Conservation of geological resources is a new initiative that is based on the concept of utilising resources without destruction. This is far from the traditional concept of the geology that aims to utilise the earth resources destructively. Conservation, like conservation biology is usually associated with

flora and fauna but seldom takes into consideration the landscape and geological resources, which is really the basis for the ecosystem. Thus, the concept of conservation biology is systematically implemented in developing the concept of conservation geology. Geological conservation is a relatively new in Malaysia. The concept of national parks, nature reserves, Sites of Special Scientific Interest (SSSIs), Regionally Important Geological/Geomorphological Sites (RIGS) and geological monument have been introduced as a classification method for the purpose of planning and research in conservation. Indirectly, geological conservation is very relevant to ecotourism, an industry that is getting more attention from domestic and foreign tourists.

3
GEOTOURISM: SUSTAINABLE APPROACH TOWARDS CONSERVATION OF GEOLOGICAL HERITAGE

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SUMMARY

Most well known tourist areas share some similar elements: uniqueness, fascination, rarity, and sense of ownership. These elements form part of the 'intrinsic values' found in the history, archaeology, anthropology, culture, biology, and geology. The development of geological knowledge up to recent years has focused on the exploitation of earth resources for mans well-being. As such little has been done to preserve these resources. Conscious efforts need to be made to ensure continued preservation of important geological heritage while at the same time developing these geological resources. Geotourism is a concept introduced with that end in mind. Geology attempts to trace and understand the history of the origin and development of the earth since several thousands of millions years ago. In some ways this effort could be regarded as a continuation of the study on the historical development of the universe as carried out by the astronomers; followed on by the study on human civilisations (archaeology) and history of modern man (history and culture). Through such an attempt geology has contributed important concepts, which uphold the 'intrinsic values' mentioned earlier. Examples of these concepts are time and space, earth dynamism versus very slow changes, and existence (origin) and extinction. These concepts when combined with the beauty of the rock formation and their morphologies can enrich the tourism industry while ensuring that the existing geological heritage is preserved. Although geological knowledge has been extensively used in tourism industry, the geotourism concept itself is not clear. This paper will discuss how the geological intrinsic resources have been used to develop some world renowned tourist areas. We also intend to show how the geo-tourism concept can be used holistically to develop the tourism industry by focusing on the Langkawi Islands as a specific example.

4
GEOTOURISM: POTENTIAL OF GEOLOGY IN DEVELOPING THE TOURISM INDUSTRY IN MALAYSIA

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SUMMARY

Geological resources were advocated as the main basis for sustainable tourism development and land use planning. This suggestion requires geological resources to be categorised as a conservation element, which would be the opposite of the traditional method of exploitation. In relation to this, geological resources need to be evaluated and managed from a new perspective by taking into account the potential long-term value and permanence. Geological tourism is a development towards this goal, which looks at geological resources as a natural heritage. This approach can balance the potential long-term and short-term exploitation of geological resource. The concept of geotourism defines geological resources as two classes, namely, the physical and the intrinsic. As the 21st century approaches, the consideration and assessment based on the concept of geotourism shows that the intrinsic value of geology resources will continue to increase the potential of geological resources in the development of the tourism industry will be enhanced.

5
GEOLOGY IN THE MALAYSIAN TOURISM INDUSTRY

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SUMMARY

Geology plays a very important role in tourism development in many countries in the world. Most of the world-renowned natural wonders have some significant geological background. Although geology is perhaps a strange word to most of the Malaysian public, most of them have seen many geological wonders around them. Rocky mountains, ridges and hills, beautifully carved limestone towers and caves, swirling rivers and charming waterfalls, calm and peaceful lakes and valleys, rocky or sandy coastlines, beautiful rocks and minerals and interesting fossils are among the many things that geology portrays for us to appreciate, to learn and to take care of. Most of the geological heritage has been in existence long before human civilization. Since their appearance is so monumental, some of them have been associated with

myths that attract the curious public to visit them. Several examples of Malaysian natural wonders will be highlighted in this article to see their geological significance as well as their myths.

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CONSERVATION GEOLOGY : A CASE FOR THE ECOTOURISM INDUSTRY OF MALAYSIA

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SUMMARY

The tourism industry in Malaysia currently ranks second in terms of income generation and immense pressures are put on ecotourism as a means for attracting tourists to environmentally sensitive areas. The challenge facing the geologist today is to provide geological data and translating this into information on geological heritage. This will assist in the identification, ranking and prioritization of geological sites, while at the same time increasing the intrinsic value of the particular tourist destination. Lacks of knowledge, unintegrated planning and low public awareness have already resulted in irreparable damage to some geological monuments. Several unique tropical karst morphology has been destroyed through quarrying for rock aggregate, cement and dimension stone. The case for Langkawi Islands and Mount Kinabalu are presented.

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GEOLOGICAL HERITAGE OF MALAYSIA: AN UNTAPPED RESOURCE

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SUMMARY

In line with the emergence of ecotourism globally, Malaysia has experienced a rapid growth in nature tourism in the country. Several areas have been developed and have become extremely popular destinations for nature tourism, such as Mulu Caves, Sarawak; Sabah Parks, Sabah; Langkawi Islands, Kedah; and National Park, Pahang. Presently emphasis is given to tropical biodiversity and adventure. For instance, at the National Park, activities are focused on "observation of undisturbed diversity of habitats and plant communities, jungle trekking, canopy walkway, cave exploration, shooting the rapids, and climbing Mount Tahan". Meanwhile the Kinabalu Park boasts of a place for "relaxing and doing nothing, and enjoy clean air, scenery and cool mountain temperature". These and all the other places accentuate plantlife, animals and birds.While the National Park is famous for its ancient tropical forest, it contains geological heritage that is still largely unknown to the public and policy makers. Geological evidences indicate that non-marine sediment deposited after the first time 'Malaysian land' emerged from the sea is best preserved in this area. The continental sediment is of Triassic-Jurassic age, which may probably contain dinosaur fossils. These are potential geological resources that can be further developed. The beauty of the landscape is mainly associated with sandstone formations crafted by running water. Kinabalu Park in Sabah is the only area in Malaysia with remnants of glacial erosion. The uniqueness and. majesty of the peaks of Mount Kinabalu is a manifestation of glacial processes, which ended about 10,000 years ago. The mountain is one of the youngest granitic batholiths that is believed to be still in the process of being uplifted by tectonic forces.

Both these natural wonders are national geological heritage. Several other sites have also been identified as being in this category. However, none in Malaysia has been legally established as monuments warranting systematic preservation as a geological wonder. Efforts are being undertaken to identify the legal and administrative instruments that will initiate the recognition of these geological heritage as national natural monuments. With their establishment as national monuments they can then be used to enhance the tourism industry.

8
LANGKAWI ISLANDS : GEOLOGICAL MATERIAL AND LANDSCAPE AS TOURISM DEVELOPMENT RESOURCES

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SUMMARY

In general terms, geological knowledge serves the nation in to ways. Firstly, it is directly associated with the exploration and extraction of metals, minerals, water, petroleum and gas as well construction materials. Secondly, the knowledge provides a unique understanding of processes involved over millions of years, in the formation of various rocks, landscapes, and places of interest. The knowledge emphasises a unique concept of time and space, an extremely slower rate of internal and external earth processes over time, and the emergence and disappearance of various rock formations and landforms. The whole concept forms the basis of natural history, which has inspired human adventures and enhances knowledge that generates a sense of belonging, perception and appreciation of nature.

Basically, intrinsic geological resources can be divided into two categories: earth materials and landforms. Earth materials include soils, rocks, sands, gravels, boulders, fossils, ores, gemstones and mineral water. These materials are specially formed over various rock formations, through geological processes governed by specific conditions. The potential value of these materials is appreciated through beauty, rarity, uniqueness, endurance, age, and how much knowledge could be acquired from each occurrence. In the larger formations, the beauty, fascination and uniqueness are expressed in various landforms such as nature and shapes of islands; white, black, and raised beaches; spits; sea stacks; limestone cliffs; erosional platforms; sea notches; caves; collapsed limestone roofs; karst topography; hogback and cuesta; dip slopes; plateau; canyon; river valleys; lakes; rapids and water falls. The formation of each landscape (morphologic feature) is the product of interactions of nature, which in turn are controlled by rock types, their structures and the stage of exogenic processes acting upon them. The value of the morphologic features relates to their uniqueness, fascination, role and knowledge of formation.

The Langkawi Islands are rich in intrinsic geological resources, and represent the only location that still preserves evidences of the earliest episodes that evolved over the natural history of Malaysia, some 600 million years ago. No doubt that some of the landforms and beautiful places in Langkawi have become the centre of tourist attraction, however, many more places and geological features are yet to be explored and developed. This paper highlights some of the intrinsic geological resources, and discusses their potential for development in the tourism industry.

9
STRUCTURAL EVOLUTION OF LANGKAWI ISLANDS

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SUMMARY

Langkawi Islands have a special geological significance because of the exposed rock outcrops and the most complete rock sequence in the Malay Peninsula. The oldest rock of this country is also found here. With all these characteristics it is possible to do a detailed structural geological study of the various rock formations and further to interpret the deformational history suffered by rocks of this area.

The apparent structural differences between the Lower Palaeozoic rocks (Machinchang Formation and Setul Formation) and the Upper Palaeozoic rocks (Singa Formation and Chuping Formation) have been interpreted as the result of a deformation that occurred during the Early Devonian time (approximately 370 million years). This deformation produced overturned to recumbent folds as the result of almost east-west compression affecting only the Lower Palaeozoic rocks (The Upper Palaeozoic rocks were not yet deposited).

A second and weaker deformation episode affected both rock groups (Lower Palaeozoic and Upper Palaeozoic). As the result of this deformation, the structure of the Lower Palaeozoic rocks became more complex, although the rocks of the Upper Palaeozoic produced only open and slightly asymmetrical folds. The compression direction is approximately north-south and is interpreted to act during the Late Permian (approximately 250 million years).

The third deformation was due to the compression from the east-west direction, the same direction as the first, but was less intensive. This compression possibly continued for quite a longer period. As the rock properties changed to become more brittle (possibly as the result of uplifting), a major faulting took place in the area. The resulting fault is known as Kisap Thrust Fault. This fault plays a major role in controlling the rock distribution in the area. Normal faulting that followed the granite intrusion is interpreted as the last episode of deformation suffered by the rocks of this region. Since then, this area is believed to be tectonically stable until today.

10

IGNEOUS ROCKS OF LANGKAWI ISLANDS

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SUMMARY

The igneus rock (granite) covering a large part of the Langkawi Islands is made up of two main bodies, viz., the Gunung Raya intrusion and a system of interconnected intrusions at Pulau Dayang Bunting, Pulau Tuba and Kuah leading to Teluk Apau. This Triassic granite is grey coloured, medium to coarse grained and is porphyritic. Phenocrysts of alkali feldspar attain a maximum length of 6 cm. Also present in small amounts are fine-grained late phase granite. The intrusion of granite into the sedimentary formations is responsible for the copper, bismuth and galena mineralizations together with associated skarn minerals. This granite body itself is altered in parts into tourmaline greisens. Some merely changed in texture into fine-grained granite while some minor granite sills are found in the sedimentary rock layers on Pulau Tuba.

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GEOLOGY OF THE MACHINCHANG FORMATION

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SUMMARY

Facies study of the sedimentary rock of the Machinchang Formation suggests that the facies repetition is related to the fault. The deposition of the sediments started in a fluvial-marine environment (probably deltaic), which subsequently changed into fluvial environment when the basin filled up or when the sea level fell. The sediment of the Machinchang Formation was then deposited in either a shallow marine or lagoonal environment following the subsequent sea level rise.

Based on the new structural information, especially from outcrops along new roadcuts, it is found that the structure of the Machinchang Formation is not as simple as previously interpreted. Clearly, there are many overturned beds especially in the sequence, which is exposed from Tanjung Hulur towards Tanjung Chinchin. The overturned beds are related to the presence of several reverse faults, which form a series of duplex structure. The overturned bed are also observed at outcrops near the water tank to the west of Teluk Kubang Badak and is also interpreted to be related to an eastward thrust fault. This study also found that the structural trends in this formation vary across the major lineaments. Five structural trends have been recognised, each one situated in fault blocks designated as A, B, C, D, and E. The major lineaments that separate the blocks are interpreted to represent faults based on the presence of many faults in the same trend as the major lineaments observed in the field. The changes of the structural trends are related to the rotational movement of the major fault planes.

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FOSSILS OF MACHINCHANG FORMATION

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SUMMARY

The Machinchang Formation is the oldest rock formation in Malaysia. The top part of the Machinchang Formation exposed at Pulau Jemuruk and the area around Teluk Kubang Badak consist of sandstone, siltstone and shale which yield various kind of fossils. Although the main fossil constituents are trace fossils, the most important discoveries are the trilobites and brachiopods. Among fossils found are trilobites *Saukia* sp., ?*Saukioides* sp., ?*Acontheus* sp. and *Eosaukia* sp., brachiopod ?*Eoorthis* sp. and ichnofossils like *Phycodes pedum* Seilacher, *Teichichnus stellatum* Baldwin, *Palaeophycus* sp., *Chondrites* sp., *Palaeodictyon* sp., *Arenicolites* sp., *Planolites* sp., *Thallasinoides* sp. and *Skolithossp*. The fossil assemblage generally indicates an Upper Cambrian age. Based on the fauna and lithological succession it can be interpreted that the Upper Cambrian of Pulau Jemuruk and Teluk Kubang Badak was deposited in a shallow marine environment. The shifting of barrier bars played a very important role in changing the environment from an open marine to enclosed (behind bar) basinal condition.

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ROCKS OF SINGA FORMATION OF THE LANGKAWI ISLANDS

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SUMMARY

The Singa Formation on the Langkawi main island consists of arenaceous argillaceous sequence, part of which has been metamorphosed due to the Gunung Raya granite intrusion. Massive black pebbly mudstone and interbedded shale-siltstone-sandstone are the two main lithologic units found in this formation, with the interbedded unit normally overlain by the pebbly mudstone. The shale-siltstone-sandstone unit is very rich in shallow marine sedimentary structures and trace fossils. The dropstone structure and the variation in shape, size and origin of pebble: which are randomly distributed suggest that the pebbly mudstone of the Singa Formation is of marine glacial diamictite. Lower Permian (Asselian-Sakmarian) fauna are commonly found in the upper part of the shale-siltstone-shale unit and the lower part of the pebbly mudstone. The sedimentary structures and fossils indicate that the Singa Formation was deposited in a shallow marine shelf, which became deeper as a result of sea level changes closely related with continental glaciation and interglacial melting. Based on lithological (sedimentological) and faunal evidences, it is very clear that the Langkawi islands were very close to the Gondwana Supercontinent (Pangea), which had undergone global climatic changes from a cold regime during early Lower Permian to warmer conditions during late Lower Permian.

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GEOMORPHOLOGICAL MAPPING IN PULAU TIMUN

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SUMMARY

Topographic maps normally contain limited information for geomorphologists. Therefore, geomorphic mapping is one of the scientific methods to present morphologies in order to reflect the shape of the earth surface in detail. A geomorphological mapping of Pulau Timun, Langkawi, drawn from the interpretation of aerial photographs and topographic maps has been

carried out with, classification of geomorphic units done according to Van Zuidam (1985). The studies show that Pulau Timun consists of three geomorphic units (according to morphogenesis) i.e. karst origin, denudational origin, and marine origin. The limestone terrain, which covers 70% of Pulau Timun is of karst origin which consits of karst plateau, karst slopes and hills, star karst zones (labyrinth), conical karst zones, tower karst hills and mogotes, karst alluvial plains, karst border plains, dolina, uvala and sinkholes. Detrital rocks are of denudational origin and consist of denudational slopes and hills. Morphologies of marine origin cover only small areas of the island and can be divided into sub-units of marine cliffs and notch zones, beaches, non-vegetated tidal flats, vegetated tidal flats and marine flood plains.

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VALUING THE PHYSICAL CHARACTERISTICS OF BEACHES ON THE ISLAND OF LANGKAWI

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SUMMARY

Recognition of the inherent physical properties of beaches on the Island of Langkawi is important so that the beaches can be valued for what they are, rather than solely for their commercial value. One of the interesting natural features on the Island is the black sand at Pantai Pasir Hitam, which have been derived from granites enriched in tourmaline and ilmenite. Granitic beaches are generally characterised by the presence of boulders, which display naturally sculptured forms. They also tend to have a higher proportion of coarse grains giving the sand a gritty feel. On the other hand, beaches derived from sedimentary rocks and alluviums have relatively less coarse grains and are smoother to handle. The best-ranked beach, based on the physical intrinsic properties, is derived from the sedimentary rocks of the Machinchang Formation.

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INTRINSIC GEOLOGICAL RESOURCES OF TAMAN NEGARA

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SUMMARY

Taman Negara as a national park has not been fully exploited. As an example, it contains some geological resources to attract tourists. Its mountain, Gunung Tahan is the highest in Malaysia and the Tahan River, which contains beautiful rapids, waterfalls, and limestone caves has always been a primary natural attraction. These physical natural resources, however, have only 'initial' attraction power, which means that once they have been given the once over; they cease to be less of an attraction. Nevertheless, there remain numerous intrinsic geological resources, which have not been highlighted, such as the origin of sedimentary deposition, geological evolution of the Peninsular Malaysia itself, and the actual processes by which the landforms have been crafted by nature. Such intrinsic resources which are discussed in this paper, not only will provide the initial attraction power, but can also lead people to come back on return visits, especially for education-related activities.

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PALINOLOGY OF THE JURASSIC-CREATCEOUS ROCKS IN TAMAN NEGARA

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SUMMARY

Due to a lack of macrofauna recorded in the Jurassic-Cretaceous rocks of Peninsular Malaysia, palynomorphs, as an alternative measure in age determination, are the most valuable source of data to be acquired by geologists. Beside establishing a more specific age, palynomorphs can be utilised in interpreting the palaeoclimate during which the sediments were deposited.

However, there is very little palynological data from Jurassic-Cretaceous rocks, especially those in and around the Taman Negara, recorded by previous workers. A study on the occurrence of palynomorphs in the Jurassic-Cretaceous rocks in the Taman Negara, Pahang was thus undertaken. Some 32 potential palynomorph-bearing outcrop samples were collected from various localities in the south and south-east of Taman Negara. Most of the samples studied yielded a reasonable number of palynomorphs which were not identifiable due to poor preservation. After a thorough microscopic study, some poorly- to partly well-preserved ones were able to be identified. The identified palynomorphs were systematically described and after conducting a comparative study, it was found that they have a close resemblance to ten taxa and four tentative names were given (further study is required to allow definitive naming). In general, only a Jew well-preserved palynomorphs were observed in every sample studied and they could not be utilised as palynomorphs assemblage in interpreting geological aspects. The abundant long ranging fungal spores, observed in several samples, were not suitable to be used as age indicators because of the wide range in age. A thorough comparison study with other areas in Peninsular Malaysia suggests that the age of the rocks is late Early Cretaceous (approximately 100-110 million years) based on the presence of Araucariacites sp. (widely recorded in Aptian-Albian). Due to the absence of Cicatricosisporites sp. and Classopollis sp. in the samples studied, it is not possible to propose that the age of the rocks are as early as Early Cretaceous. The most probable climate condition, during which the sediments were deposited, is believed to be warm and humid. This interpretation is based on the absence of cold climate-related bisaccate pollen and the dominance of fungal spores. Apart from its direct contribution to interpreting geological aspects, palynomorphs can be highlighted and introduced to the public as an interesting geological heritage as they are already familiar with macrofossils. As a start some eye-catching illustrations of palynomorphs with simplified descriptions can 'be displayed to the public together with other geological materials in an exhibition area. It is hoped that by introducing some geological valuable heritage to the public, they will gradually develop a sense of loving and caring and they will probably take a big step in conservation efforts in order to save the national heritage which is to be handed down to our future generations.

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GEOLOGY AND GEOMORPHOLOGY OF THE TOURIST AREA IN TAMAN NEGARA

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SUMMARY

The study area is located in Taman Negara, between Kuala Tahan and Kuala Keniyam. Three main rock units exposed in the area are the PermoTriassic rock unit, the Tembeling Group and volcanic rocks. The Tembeling Group forms several strike ridges trending

southeast-northwest, the PermoTriassic rocks occupy undulating low land areas and the volcanic rocks formed small hills. The Tembeling Group was deposited within a continental environment during Jurassic to Cretaceous times, while the Permo-Triassic rock was deposited under marine conditions. The volcanic rocks are probably Permian.

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GEOTOURISM OF KINABALU PARK: PRELIMINARY STUDY ON POTENTIAL DEVELOPMENT

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SUMMARY

Geotourism can be recognised as the provision of interpretative and service facilities to enable tourists to acquire knowledge and understanding of the geology and geomorphology of a site beyond the level of mere aesthetic appreciation. Systematic effort in bringing about the concept of geotourism on a practical basis started in 1996, with Taman Kinabalu as the chosen site, where several sites with geotourism potential have been identified. These include the Kinabalu Plateau, Panar Laban, Lows Peak, Poring Hot Spring, and Pinosuk Plateau. These areas are being explored as potential geotourism sites. Several geotourism development plans are in the planning process and some of them have already been implemented in promoting the concept of tourism geology in Taman Kinabalu. These plans include tourism geological mapping, establishment of a mini geological museum, active geological exhibition, public information and rockarium.

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GLACIAL GEOMORPHOLOGY OF KINABALU PLATEAU

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SUMMARY

The Kinabalu Plateau, an elevated flat area with several small peaks at a height exceeding 3,660 m, represents a unique morphology that is different from other elevated plateaus in the wet tropics. This plateau is made up of fresh granodiorite that has been smoothened and polished by glacial erosion. The area exhibits several mall and medium sized morphological features, such as U-shaped gullies and valleys, hanging valleys, cirques, polished surface, cresentic gouges and fractures, plucking, grooves and striation, and roche moutonnees, which are evidences of an ancient (35,000 to 3,000 years) ice sheet that once covered the peak of Mount Kinabalu. The world's temperature which become increasingly warmer in the last several thousand years did not allow the ice to remain on the plateau and to continue its erosional works. The morphology of Kinabalu plateau represents proof of crafting by an ancient glacier, the only one that has been preserved in Malaysia, and should therefore be regarded a national treasure.