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CONSERVATION GEOLOGY: A MULTIDISCIPLINARY APPROACH IN UTILIZATION OF EARTH RESOURCES WITHOUT DESTRUCTION

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SUMMARY

The new field of conservation geology requires the input of all traditional fields of geology. A successful research and development programmed for advancement of this field requires expertise from disciplines, outside of geology such as planning, law, tourism and management. Geologists should lead the development efforts and harness the multidisciplinary networking in order to ensure that conservation geology contributes to the aspiration towards achieving sustainable development.

2

KINABALU PARK-A WORTHY CANDIDATE AS A WORLD HERITAGE SITE

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SUMMARY

This paper highlights the unique of Kinabalu Park as a potential World Natural Heritage Site. The legal and administration provision, physical and biological resources as well as the management structure of the park are described.

3

GEOLOGICAL TREASURES OF MALAYSIA

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SUMMARY

Several geological treasures of Malaysia's are describes: (a) landscape/morphological elements such as the Dulit Triangle, Sarawak, the Genting Kelang quartz ridge, Selangor, tower karst and caves with associated speleothems in many localities of the country, the circular basins of Sabah; (b) type sections and type localities of most stratigraphic units, angular unconformities such as fond at the Jengka pass, Pahang and Tatau, Sarawak, sedimentological features comprising evidence for a Gondwana origin of the western domain of the Peninsula; localities of key fossils; structural evidence of textbook quality of folds, faults, and/ or those demonstrating overprinting; the chaotic deposits of Sabah and those along the Bentong suture; (c) shoreline indicators representing Quaternary sea-stands in the form of abrasional, depositional and biogenic elements; and (d) certain unique phenomena. Of the latter are three treasures that need immediate attention: an essentially complete vertebrate fossil skeleton of a bear (?) in a limestone cave of the Kinta Valley, calcareous beach rock with wind-stress features at Tanjung Balau, Johor and the huge sole markings in the Crocker turbidites just outside the Kinabalu perimeter in Sabah.

4

GEOLOGICAL SENSITIVE AREAS: PROPOSAL FOR REGULATION AND CONSERVATION

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SUMMARY

Geology encompasses scientific studies of evolution, history, structure and composition of the earth. This field has explored in depth the formation and evolution of the earth's history over the past thousand million years. The development of geology until recently emphasised exploration of earth resources for the prosperity of the nation and for fulfillment of human need. Limited efforts have been focused on conservation. Geologically sensitive areas can be defined as all area with intrinsic geological values that need to be managed and conserved from physical development. Conservation geology provides a means of protecting a geological formation or phenomenon that has special scientific value, representing different stages of the earth geological history and its transformation through various geological processes.

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CONSERVATION OF FOSSIL SITES IN MALAYSIA

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SUMMARY

Palaeontological conservation differs fundamentally from other forms of conservation because fossils need to be dug up in order to be studied. Fossil sites are there to be used rather than to be preserved untouched. The goal of fossil site conservation is good husbandry and not conservation *per se.* The main threats to fossil sites in Malaysia are from natural processes such as tropical weathering and erosion or development related activities like construction, quarrying, mining, burial and flooding. Important fossil sites for conservation are those from which type fossils, rare fossils and extensively studied fossils have been obtained. In addition to the scientific value of a site, its value is enhanced if it has other attractions for visitors. An integrated approach to developing and promoting the site is vital for its effective conservation. Conservation options include: rescuing fossils from threatened sites, leaving unthreatened sites alone and developing suitable sites for educational or geotourism purposes. In addition to protecting fossil sites, palaeontological conservation must include the proper documentation of fossil data, public education on fossils and the proper curation of fossils. Encouraging the developers, quarry and mine managers and the general public to report find to the Department of Minerals and Geosciences or universities are very important.

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LANGKAWI DROPSTONES: OUTSTANDING GLACIOGENIC SEDIMENTOLOGICAL FEATURES IN MALAYSIA

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SUMMARY

Mudstone, siltstone and sandstone of the Singa Formation in the Langkawi Islands often contain pebbles of various size, shape and origin and whose parent rocks are alien to the geology of Langkawi Islands and the neighbouring area. Unlike clasts in other common pebble-bearing rocks, these pebbles are randomly distributed within fine-grained sedimentary rocks, occasionally exhibiting drops tone structures, thereby indicating they are of marine glacial origin, being dropped by rafting icebergs in the past. The pebbly mudstone, siltstone and sandstone are known as glacial marine diamictite. The presence of these dropstones implies that Langkawi Islands were once placed joined together with other continents such as Australia, India, Africa and Antarctica in a supercontinent called Gondwanaland during late Carboniferous to early Permian time (about 280-300 m. y. ago).

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GEOLOGICAL HERITAGE OF TANJUNG BALAU, JOHOR

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SUMMARY

In Tg. Balau, Johor and in the neighbouring forelands (Tg. Siang and Tg. Lompat), there exposed metasedimentary rocks with records of tectonic history part of the Eastern Belt of the Peninsular Malaysia in them. The rock, consisting predominantly of metaquartzite, phylitte and slate; are believed to be Permo-Carboniferous age (eg. Tjia 1989; Suntharalingam 1981). Geologic event recorded in these rocks are well represented by various types of complex and classic geological structures. From their structural geometrical and orientation relationship at least three phases of deformation can be deduced. The first deformation event (D_1) is represented by structures such as tight to isoclinals folds associated with slaty and schistocity cleavages. The D_1 structures are overprinted by the second deformation structures (D). The latter produced refolded folds, periclinal folds, z-asymmetrical folds, crenulations cleavage, dextral shear zones, mullions) boudinage and etc. Both the D_1 and D_2 structures are in turn overprinted by the third deformation (D_3) structures. The latter is commonly represented by open and chevron folds as well as kink bands with steeply plunging to subvertical axes oriented in approximately east-west direction. The great diversity of the classical examples of geological structures in this area, as well as the generally continuous outcrops, permits us to understand the forms and geometry of the multiple deformational structures in greater details. It can also give an insight into the kinematics evolution of the Eastern Belt of Peninsular Malaysia (eg. Mustafa Kamal Shuib 1999). These make Tg. Balau so special, an ideal field laboratory for conducting research, teaching and learning structural geology. The presence of other geological features such as Quarternary beach deposits and piles of bauxite boulders along the coastline, is also an additional uniqueness to the geological heritage in Tg. Balau. In conjunction with the recent development of Tg. Balau into a new tourist destination in eastern Johor. It is highly recommended that these geological heritage with high scientific value) would be preserved and developed as another resources of the nation can be fully benefited.

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CONSERVATION OF GEOLOGICAL HERITAGE: CASE STUDIES OF SEVERAL GEOSITES IN SABAH

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SUMMARY

This paper highlights issues related to the conservation of geological heritage sites based on case studies of seven geosites found outside Sabah Park areas. The conservation status of, geosites within state land, forest reserve, oil palm plantation, quarry and private land were evaluated. In all the areas, the owners of land, either individuals or companies, are not bound by any legislation to conserve geosites found within their property. However, there are efforts by communities or companies to conserve and develop geosites that can bring direct benefit to them. In view of the different values, locations and settings of a particular geosite, different approach will be required to conserve geological heritage. For geosites that possess natural attraction (having both recreational and esthetical values), land owners are willing to conserve and develop the site on their own initiative. For those geosites that do not have natural attraction, a proactive approach is required to gazette them as a cultural heritage using existing legislation. Once these sites are gazetted, the participation of stakeholders, especially local communities, in the conservation and development of the site will be necessary to ensure its success.

9

GEOMORPHOLOGY AND SURFACE PROCESSES OF PULAU TIGA

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SUMMARY

Pulau Tiga, which is situated on the West Coast offshore of Sabah, is one of the areas in Sabah that is still active with mud volcano activity. This island is considered unique because it was formed in a different way compared to other islands. The island morphology was formed totally or mainly by mud volcano eruptions. Three hill peaks that exist in the island today were formed by mud volcano activity that occurred hundred of years ago) and there is still a living mud volcano in that three peaks. The occurrence of mud volcanoes had attracted visits by local and foreign tourists to this island. Three types of beaches i.e. sandy, rocky and swampy recognised, are potentially attractive for recreational purposes. The beach morphology is governed by exogenous processes such as waves and tides, physical weathering and also, responsible in the changes of beach forms during the different monsoon seasons. Chemical weathering resulting from the change of chemical composition of the soils is also one of the hidden aspects for geotourism.

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MINERAL HERITAGE OF LANGKAWI ISLANDS

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SUMMARY

This paper describes the various minerals found in Langkawi Islands. Places of mineral interest include Pasir Hitam with its black sandy beach, Pulau Bumbon with its variety of calc-silicate minerals, and around Kuah to Pasir Telang Hantu for their sulphide minerals. Pasir Hitam is now a centre of tourist attraction, and its black sand is due to the presence of tourmaline mineral. Pulau Bumbon has an attractive collection of minerals such as vesuvianite, garnet, actinolite, axinite traces traces of azurite and malachite. Potential ore sulphide minerals such as chalcopyrite, galena, sphalerite, pyrrhotite and traces of bismuth have been explored before World War II. The mineral variety found in the islands is a remit of igneous granite intrusions into the surrounding active sedimentary rock mainly of limestone about **200** million years ago. The granite itself shows textural variations, some having coarse texture with large phenocrysts. Tourmaline is a common mineral in the Langkawi granite and the tourmaline in the Pasir Hitam sand results from the weathering and erosion of the tourmaline-rich Gunung Raya granite body.

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GEOTOURISM OF BUKIT KLUANG, BESUT TERENGGANU

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SUMMARY

The Bukit Keluang and the neighbouring isolated hills are famous seaside picnic destination in Besut District, Terengganu. These isolated hills are made up of sedimentary rock sequence known as the Bukit Keluang Formation. A visit to this picnic site will be more meaningful if one can understand the history of the development of these beautiful landscapes. Apart from relaxing on the beach and having other recreational activities, visitors can be provided with some knowledge about nature and natural processes. For the case of the Bukit Keluang, the local authority should build a mini-museum for displaying collection of rocks and fossils from the Bukit Keluang Formation. Apart from rock and fossil specimens, this mini museum should also display posters in form of photographs and diagrams to illustrate the presence and the development of isolated hills, caves, fossils and beaches in the area. Posters that can explain the changes in shorelines and sea levels are also important for the understanding on how these natural processes carved the landscapes around Bukit Keluang area.

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ANCIENT NOTCHES: A NATURAL HERITAGE THAT SHOULD BE CONSERVED

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SUMMARY

A sea-notch is found at the foot of a small hill of Pulau Tanjung Dendang, about 23m above the present sea level. The limestone wall of the sea-notch is encrusted by *Saccostrea cucullata*. At the base of the sea-notch, there is a shell bed. The orientation of the shells indicates that they were deposited by the wave. The shells were transported by the wave from a deeper environment close to the area. There was a secondary calcite deposit, which was originally a stalactite, now forms a limestone tower. The sea-notch is a natural heritage, which must be conserved.

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MAPPING AND UNIQUE GEOMORPHOLOGY FEATURES OF EASTERN LANGKAWI ISLANDS

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SUMMARY

Geomorphological mapping is another kind of method to map earth surfaces landforms (morphology) with the purpose to get a detail information of the earth surfaces landforms in certain area. Air photographs are able to provide informative earth surfaces in three dimensional, which is the main source of information in geomorphological mapping work at the eastern of Langkawi Islands. The geomorphological units are classed accordingly to its origin (morphogenesis), either as units of karst, oceanic, fluvial, denudation structures or denudation origins. The geomorphological units are also been divided according to its degree of steepness, either gentle slope with minor steepness, moderately steep terrain or very steep terrain. Seventeen geomorphological units were identified and mapped, which consists of three denudation origin units, four oceanic origins, two-denudation structures origin, seven-karst origin and one fluvial origin unit. The result from the study is a geomorphological map showing the terrain units and geomorphological units of the study area. Besides that, some geomorphological units can provide interesting landscapes and thus become the geological heritage of this area, which should be conserved and maintained of its occurrences.

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PALYNOMORF: HIGH VALUE GEOLOGICAL HERITAGE

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SUMMARY

Palynology research was conducted at some localities of southern Peninsular Malaysia, mainly in the state of Johore. The results from this research can be used as additional data in interpreting geological aspects or as an alternative data if there is no occurrence of many macrofossil. Palynology data obtained from around Paloh, Gunung Panti; Bukit Mambai and Bandar Tenggara have been useful in interpreting geological aspects. The palynomorf assemblege is characterised by dominant occurences of *Cicatricosisporites australiensis* together with other species in sendimentary rocks exposed along the Paloh-Kluang road, which is believed to be of Early Cretaceous (Valanginian-Barremian or ±120-110 million years). The range of age interpreted is much shorter compare to the interpretation done earlier which from Jurassic-Cretaceous. The palynomorf assemblege identified from Gunung Panti and Bukit Mumbai, which is characterised by dominant *Classopollis* sp. can be used to interprete the weather conditions during sendimentation. *Classopollis* sp. is related to the flora that lives in hot and dry weather. In comparison, the occurrences of *Stenochlaena* sp. and *Pediastrum* sp. in sedimentary rocks at Bandar Tenggara is related to swampy fresh water conditions. Palynomorf are important micro sized art particles, which also provides information on the wider aspect of geology. Thus, the diverse be valued and observed for its unique features as a heritage, equivalent to other macrofossils.

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REQUIREMENT AND ALLOCATION OF LEGISLATION FOR GEOLOGICAL RESOURCES AND LANDSCAPE CONSERVATION IN MALAYSIA

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SUMMARY

Legislation is an important tool to implement the idea of geological resource and landscape conservation. Even though no specific and comprehensive laws have been established to protect these geological and landscape resources in Malaysia, certain laws are applicable. Generally, there are four categories of legislation related to resource conservation. (i) Laws that directly influence the conservation of geological resource diversity (e.g. Geological Survey Act 1972 and Antiquities Act 1976); (ii) Laws that **indirectly** influence the conservation of geological resource (e.g. Forestry Act 1984, Environmental Quality Act 1974, Protection of Wildlife Act 1972 and National Parks Act 1980); (iii) Laws related to **nature resource management and utilisation** (e.g. Public Parks and Green Ordinance 1993 and National Parks and Reserves Ordinance 1956 (amendment 1990)) and (iv) Laws **indirectly impact on the diversity of natural resources** (e.g. National Land Code 1965 and Town and Country Planning Act 1976).

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A LARGE VERTEBRATE FOSSIL AT NAGAMAS CAVE, BUKIT LANNO, KINTA VALLEY

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SUMMARY

One of the twin limestone caves at Bukit Lanno near Kepayang Village, Kinta Valley, Perak, contains a large vertebrate skeleton embedded in its ceiling. The fossil is almost complete and cursory examination of the exposed parts of its destination suggests a carnivorous or omnivorous animal, possibly a small tiger, a bear, or a wild dog. The fossil-bearing ceiling is about 38 m above the Kinta valley pain, while its cave floor is 31 m above the plain. A complicated morphological sequence of event comprising subsurface cave formation, subaerial exposure through general denudation involving a vertical distance of two scores or more metres, travertine-fillling, renewed partial burial and a second phase of exhumation seems necessary to explain the peculiar position of the fossil. These considerations suggest the fossil to be more than 700,000 years old. In the early 1990s, one sample of the fossil-embedding travertine was studied by Atsushi Tani (then a doctoral candidate at the University of Osaka, Japan) using the electron-spin resonance method. The preliminary result was encouraging with respect to the earlier estimated age. For practical reasons only in early 2000, Dr Tani and several local collaborators were able to deploy dosimeters that are expected to put the ESR- date at a film footing. Results are expected to be available by mid-2001.

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RADIOLARIA FOSSILS FROM THE OPHIOLITE SEQUENCES AT BALIOJONG VALLEY, TANDEK, SABAH

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SUMMARY

Radiolaria is a group of siliceous microfossils, which form radiolarian chert. The chert is found in the deep marine environment, which is lacking the supply of clastic material. The occurrence of radiolaria in the Baliojong Valley gives us information about the age of the oldest sedimentary rocks in Sabah. Twenty-three species of radiolaria were identified. The radiolaria can be divided into two assemblages. The first assemblage is composed of *Archaeodictyomitra lacrimula*, *Pseudodictyomitra carpatica*, *Pantanellium squinaboli*, and *Archaeodictyomitra pseudoscalaris* which indicate Barremian- early Aptian age. The second assemblage consist of *Stichomitra communis*, *Pseudodictyomitra pentacolaensis*, *Thanarla veneta*, *Dictyomitra obesa*, *Dictyomitra gracilis*, *Pseudodictyomitra pseudomacrocephala*, and *Xitus mclaughlini* which indicate an age of Albian Cenomanian. The whole radiolarian population indicates an age from 95 Ma to 125 Ma. The ophiolite in the Baliojong Valley exhibits several repeated sequences. The sequences actually belong to the same unit as proven by radiolaria. The sequence repetition therefore indicates stacking by overthrusting.

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THE GENERAL GEOLOGY OF THE NIAH CAVES AREA, SARAWAK

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SUMMARY

Soon after the cave was first excavated in 1954 by the Sarawak Museum, the Niah Caves area, located in the northern part of Sarawak, had been the centre of tourist attraction since reported as an archaeological site where early mankind first settled in the region. The (cave) area has also beautiful geological formations such as karst topography and the great cave system (developed) within the limestone formation; enveloped by thick, green tropical forest hosting many species of flora and fauna. Tourism in the cave area would be further enhanced if these natural components were developed simultaneously with the existing archaeological heritage of the cave. Thus, the Niah Caves area had been identified as a potential site for the development of an ecotourism (geotourism) industry in the country is prioritized for detailed geological investigation under the IRPA Project and is undertaken jointly by the department with the Institute for Environment and Development, Universiti Kebangsaan Malaysia at Bangi since 1997. The Niah Caves area is underlain by the limestone formation named the Subis Limestone Member of the Sibuti Formation; surrounded by a country rock formation that consists mainly of alternations of shale and sandstone. Niah Great Cave is the name given to the great cave developed in the limestone formation and estimated to cover an area of 600 m width and extends about 900 m. It consists of many chambers connected by many small passages. There are also a great number of interesting geological features within the great cave, namely the bedding plane controlled roof, vertical and horizontal grooves, scalloped surfaces, and many others such as various shapes of floor and roof cavities. The floor of the cave is covered mainly by guano, but in most passages, the floors are overlain by boulders of limestone and clayey deposits. Relics of early human inhabitation such as paintings on the wall and the boat remains were observed. Based on the fossil content, the limestone formation was developed during early Miocene, estimated to be 15 million years ago. However, later on the caves were developed within the limestone formation in a subaqueous condition during the mid Pleistocene, estimated at 1 million year ago. The caves were fully developed when the water level dropped by about 150 m to the present level.

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PANAR LABAN ROCHE MOUTENEE, KINABALU PARK, SABAH

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SUMMARY

The Panar Laban Plain, situated south of Kinabalu plateu and ranging in height between 3,200m and 3,350m, is the last camping point for the climbers of Mount Kinabalu. This gently sloping narrow plain sits at the foot of steep Panar Laban rock cliff and is made up of rocky bumps, interspersed by miniature plants. Studies show that the arrangement of these almost elliptical protrusions is rochee moutonnee feature, i.e. a geomorphological manifestation, which is the result of glacial abrasion during the last Pleistocene age. Ancient glacial processes, which rarely occur in the humid tropics, have carved these geological features, making them unique and extraordinary on a regional basis. The Panar Laban Rochee Moutonnee is evidently a geotope that contains anparalleled historical record of unusual Earth processes in Malaysia. This landscape is well preserved and should be declared as National Protected Site. Geotourism activities can be introduced to expose the public to national geological heritage.

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NOTCHES IN THE LIMESTONE HILLS OF KINTA AND THEIR ECOTOURISM IMPORTANT

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SUMMARY

Notches and mogote hills in the tropics are part and parcel of the geomorphologic processes, which are shaping the limestone landscape in the humid tropics. Notching into the sides of the limestone by lateral solution occurs on land as well as in coastal limestone outcrops, which are often referred to as nips. The best-developed notches in the limestone hills of Peninsular Malaysia occur in the Kinta Valley and they are distributed at several locations in Gunung Rapat, Tambun, Tasek, Terendum, Lanno, Datok, Cheroh, Kuang, and Tempurung etc. The notches in the Kinta Valley owe their origin to the continental processes prevailing during the Late Quaternary to Holocene time. It is believed that the present mogote hills in the Kinta Valley were shaped to their present forms after undergoing several changes of alternative humid and dryer climatic conditions related to the early Quaternary Glaciations. The basic forms of the mogote hills in the Kinta Valley were probably formed by Late Quaternary (probably from between 70,000 to 500,000 years ago). The notching was then superimposed on the mogote landscape thereafter. The best defined notch found in the limestone hills of the Kinta Valley consists of several steps of flat roof undercuts indenting from 1 m to 7 m into the side walls of the limestone hills. They occur at the heights from 1 m to 3 m above the present ground level (alluvial plain). From about 3m to 21m above the alluvial plain, notching takes the form of downward curving indentation referred here as scalloped notches. It is postulated that the flat roof notches were formed as a result of the foot swamp undercut which took place under wet humid tropical climate since the Holocene time (12,000 years). The scalloped notches are postulated to be the result of lateral solution-indentation by soil-cover or seasonal swamp condition existing between 70,000 - 500,000 to 12,000 years ago (Holocene). The notch-caves are major tourist attractions in the Kinta Valley because of their use for siting of places of worship. Several notching indentations into the side walls of Gunung Rapat and combined with other karstic features, take shape as spectacular nature monuments with Special Scientific Interest and these should be conserved in its natural state with least modification and tampering for purpose of research, education and ecotourism.