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Geopark as an answer to geoheritage conservation in Malaysia – The Langkawi Geopark case study

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Abstract: The interesting Palaeozoic geological history and amazing island karst landscapes are among the geological features of Langkawi, which have heritage value of national and regional significance. In order to conserve these geological heritage resources, the entire Langkawi Archipelago has been declared the Langkawi Geopark in May 2006. For Langkawi Geopark geoheritage conservation, 90 identified geoheritage sites were packaged into 3 geoforest parks, 3 geological monuments and several protected geosites. Several highly significant geoheritage sites were packaged into geopark trails or incorporated into existing nature tour trails. As for geotourism and public awareness, public friendly information panels and brochures were provided. The creation of Langkawi Geopark has paved a clearer path for the geoheritage conservation agenda in Malaysia. This achievement would not have materialized without serious commitment from various institutions, particularly the Malaysian Geological Heritage Group, Langkawi Development Authority, Department of Mineral and Geoscience and Forestry Department of Peninsular Malaysia. Langkawi Geopark is intended to be a model for sustainable development of geological heritage resources and to become a catalyst for future development of geoparks in this region.

INTRODUCTION

Appreciation for heritage value of the earth has grown steadily over the years. The global scenario clearly shows that such appreciation developed earlier and better in the developed nations, where earth heritage sites have been sustainably developed within the various kinds of National Parks and World Heritage Sites. The developing nations on the other hand, due to their higher dependency on primary resources, generally faced stiffer challenges and hindrances against such development. Equally important is the generally lower level of awareness on the fragility of the natural environment as well as the importance of sustainable development on earth heritage resources. As we are entering a more and more borderless world, such excuses should be slowly but steadily reduced. For the benefit of all mankind and future generations, alternative concepts of conservation such as the Geopark Concept of the United Nations Educational, Scientific and Cultural Organization (UNESCO) could be deployed in order to protect our precious earth heritage without depriving local communities of their socio-economic benefits from promoting geoheritage resources for tourism, research and education. Hence, this smart concept shows that conservation could work side by side with poverty eradication as well as literacy enhancement. In Malaysia, the recent inauguration of Langkawi Geopark can be seen as a giant leap forward in supporting sustainable development of Malaysia's geoheritage. This paper highlights the reasons behind the formulation of the Langkawi Geopark and geoheritage conservation within it.

UNESCO GEOPARK INITIATIVE

At the Rio de Janeiro 1992 United Nation Conference on Environment and Development (UNCED) Summit, the Agenda for Environment and Development (Agenda 21) was adopted, among which included the protection and sustainable development of geological heritage and geodiversity. It was recognized that geology and landscape have profound influences in society, civilization and cultural diversity of our planet. Responding to this agenda, the geopark concept was drafted in 1999 and in the year 2000 the European Geopark Network was formed, followed by the formation of the UNESCO Global Network of National Geoparks in 2001.

The geopark conservation package provides an alternative to other IUCN heritage conservation packages based on the earlier 1972 Convention concerning the Protection of the World Cultural and Natural Heritage in which many geological heritage sites were formerly protected. The provision of geoparks, which highlights the potential interaction between socio-economic and cultural development and conservation of the natural environment, certainly gives it an edge over other concepts of conservation. In other words, the geopark approach will provide opportunities to create a more balance development between geoheritage conservation and local socio-economic development. By definition, a geopark is *a territory with well-defined limits that has a large enough surface area to serve local economic development. It comprises a certain number of geological heritage sites (on any scale) or a mosaic of geological entities of special scientific importance, rarity or beauty, representative of*

*an area and its geological history, events or processes. It may not solely be of geological significance but also of ecological, archaeological, historical or cultural value (*http://www.worldgeopark.org/wwwroot/OfficialDocuments1.htm*).*

LANGKAWI GEOPARK INITIATIVE

The first in Malaysia and Southeast Asia, the Langkawi Geopark comprising all 99 islands of Langkawi was established by the Kedah State Legislative Council on 31st May 2006 and was later endorsed by the Board of the Langkawi Development Authority (LADA) on 6th October 2006. The establishment of the Langkawi Geopark was initiated by the Malaysian Geological Heritage Group (MGHG), which since 2001, has identified the potential of Langkawi Islands as a world class geopark (see Ibrahim Komoo *et al*., 2001; Mohd Shafeea Leman, 2006). The group then conducted extensive researches, planned implementation strategies, and organized networking activities with various government agencies, most importantly with LADA in selling the idea about the geopark (Ibrahim Komoo, 2002; Ibrahim Komoo and Mohd Shafeea Leman, 2004; Anuar Abdul Rahman *et al*., 2004).

The acceptance of the geopark concept by LADA and the Kedah State Government is mainly because of their common aspiration for sustainable development of Langkawi and appreciation of geological heritage resources. These have been expressed in planning documents of the Majlis Daerah Langkawi (1992, see Also Zainal Karib Abd Rahim, 2002) and Majlis Perbandaran Langkawi (2002). The decision to adopt the geopark concept by LADA is timely, as Langkawi is striving to be the leading "daylight" tourism hub in the region focusing mainly on nature tourism. The geopark concept will give Langkawi many advantages towards attaining its sustainable development agenda. As a geopark, Langkawi could enhance its ability to fulfill the following targets:

- achieving sustainable development where nature conservation is given top priority,
- multiplying tourism products based on value-added knowledge based or ***k***-tourism,
- increasing the capacity of the local community which is essential in driving its sustainable socio-economic development,
- making Langkawi the nation's leading nature education and research destination

Apart from its new branding and the potential of Langkawi Geopark to become an exclusive member of the UNESCO Global Network of National Geoparks, LADA strongly believes that the local people could benefit from the geopark agenda. This is clearly seen from the slogan created by LADA on the geopark, that says "geopark is not all about rocks, but it is also about people". People and sustainable development alone cannot make Langkawi a geopark. A geopark must have its own management body, geoheritage conservation mechanism and most important of all, geoheritage and geological landscape diversity of national and regional significance. This last aspect is where Langkawi has its strength over many other potential geoparks in the country. Langkawi has a very rich geoheritage diversity that deserves to be protected for future generations. Highlighted in the following titles are various scientific reasons for Langkawi to be developed as a geopark and various types of geoheritage conservation adopted by the Langkawi Geopark.

GEOLOGY OF LANGKAWI

The geology of Langkawi Islands today is a result of a very long depositional history under various palaeoenvironmental conditions, followed by various tectonic and magmatic events and finally by weathering and erosion events. From these events and processes, Langkawi inherits a wide spectrum of rocks with plentiful minerals, fossils and depositional and deformational geological structures. Etching of exposed rocks by forces of nature, have created even more fascinating erosional features to these rocks of Langkawi.

In general, the rocks of Langkawi Islands can be easily divided into four sedimentary rock formations and one granite formation (Figure 1). These sedimentary rock formations are the Cambrian Machinchang, Ordovician to Middle Devonian Setul, Late Devonian to Early Permian Singa and the Middle to Late Permian Chuping Formations (Jones 1981). The sequence of these sedimentary rock formations is generally younger towards the east. However, the presence of the Kisap Thrust Fault that runs more or less in a north-south direction in the eastern part of Langkawi has changed the order of this sequence dramatically. With its westward transport direction, this fault has brought much of the older Setul and possibly Machinchang Formations from the east to overlie the younger Chuping and Singa Formations along the central axis of Langkawi Islands (Figure 2). The granite suite is Triassic in age and mostly known as the Gunung Raya granite. This granite had intruded the older rock formations and turned them into various types of metamorphic rocks. The youngest geological unit is the unconsolidated recent sand and clay deposited in narrow valleys in between limestone towers, along the coastline and forming vast relicts of the coastal plains.

GEOHERITAGE OF LANGKAWI GEOPARK

The various rock formations in Langkawi possess different geodiversities in terms of rocks, minerals, fossils, geological structures, geomorphological and landscape features. Some of these geodiversities have heritage value of national and regional significance. Geodiversities of Langkawi occurred mostly within various natural exposures on rocky coasts and cliffs, peaks, caves and waterfalls.

Some highly significant exposures have been classified as geoheritage sites, containing one or more types of geodiversities of high heritage value. So far, there are more than 90 geoheritage sites identified throughout the Langkawi Geopark, some of which have been proposed for inclusion in the National Geological Heritage List. For the purpose of promotion, Langkawi Geopark is highlighting two major geological attraction. These are:

1. a complete Palaeozoic geological succession (Figure 3), incorporating the oldest rocks and fossils in the region, best preserved sedimentary structures and fossils, best sedimentological and palaeontological evidences for affiliation with Gondwanaland.
2. the most beautiful island karst landscape in the region featuring unique hills, ridges, islands and pinnacles, beautiful caves, tunnels and arches and the magnificent rare mangrove association with limestone bedrock.

For the purpose of geotourism and education, selected geosites were provided with information panels and brochures explaining the geological significance of the sites in simplified terms understandable by people from all walks of life. Several geoheritage sites were packaged together under the different geopark trails. As a strategy to promote geotourism, some of the geosites are incorporated into the readily available island-hopping packages. In such a way, tourists will learn some geology while enjoying other kinds of nature attractions. Once the tourist and the public appreciate the value of these geoheritage resources, there will be a need for us to protect these sites as more people will come and visit them. Therefore, some conservation measures should be taken by the relevant enforcement authorities to protect these valuable geoheritage resources from damage by irresponsible parties.

GEOHERITAGE CONSERVATION

Geoheritage sites within the Langkawi Geopark are mostly located within different classes of forest reserves and thus are coincidentally protected under the provided conservation act of the Forestry Department or Jabatan Perhutanan Semenanjung Malaysia (JPSM). Langkawi Geopark has adopted the concepts of protected geosites and geological monuments from the scheme introduced by Ibrahim Komoo (2003), and the more innovative concept of geoforest park introduced by Shaharuddin Mohammad Ismail *et al*. (2004) to protect those geoheritage sites within the Permanent Reserved Forest (PRF) and recreational forests. At present, the geoheritage conservation component of Langkawi Geopark includes 3 geoforest parks, 3 geological monuments and at least 30 protected geosites (Figure 4). The current lists of geological monuments and protected geosites are, however, subjected to future changes recommended by the Langkawi Geopark Scientific Committee and approved by the Langkawi Geopark Conservation Committee. The conservation measures for geoheritage sites outside the jurisdiction of JPSM is in the early planning stage.

Geoforest Park

According to Shaharuddin Mohammad Ismail *et al*. (2004, 2005), a geoforest park is a special conservation area within a PRF with outstanding geological and biological resources where protection and wise utilization of these resources are geared towards sustainable recreation, promoting multidisciplinary research and enriching community awareness about the natural integration of various forest resources. The three geoforest parks introduced in Langkawi are the Machinchang Cambrian, Kilim Karst and Dayang Bunting Marble Geoforest Parks (Figure 4), each of them is named after its geographic name and the most significant geoheritage features within the area. The total area of these three geoforest parks covers nearly 40 percent of the total area of the Langkawi Archipelago. All these geoforest parks contain a large area of permanently exposed rocks within which most of the geoheritage sites of Langkawi are found.

Machinchang Cambrian Geoforest Park

The Machinchang Cambrian Geoforest Park (Figure 4) hosts the oldest rock unit in Malaysia known as the Machinchang Formation. Despite of its very old age, this predominantly hard clean sandstone formation shows strong resistance against tropical chemical weathering, producing some outstanding and beautiful landscapes. Among the important geosites in the Machinchang Cambrian Geoforest Parks are:

- Teluk Datai and Pulau Anak Datai representing the oldest strata of the Southeast Asian region,
- Pantai Pasir Tengkorak where some good text-book examples of sedimentary structures such as load casts, ripple marks, cross-beds and fluid escapism structures are exposed (Figure 5A),
- Tanjung Buta and Pulau Jemuruk where some of the oldest living forms of the region are buried,
- Tanjung Sabung where the boundary between the Machinchang Formation and the Setul Formation are exposed.

Also located within this park are some natural wonders created by recent geological processes such as:

- Temurun waterfall which is the tallest waterfall in Langkawi developed on a sequence of thick cross-bedded sandstone,
- Telaga Tujuh waterfall with unique potholes on the bedrock of Sawar Granite,
- remnant island of Anak Datai which seasonally becomes a tombolo off Datai Bay,
- remnant island of Anak Burau which is made of granite with rare karren-like erosional features, and
- natural fountain (Figure 5B) on the rocky coast of Tanjung Chinchin.

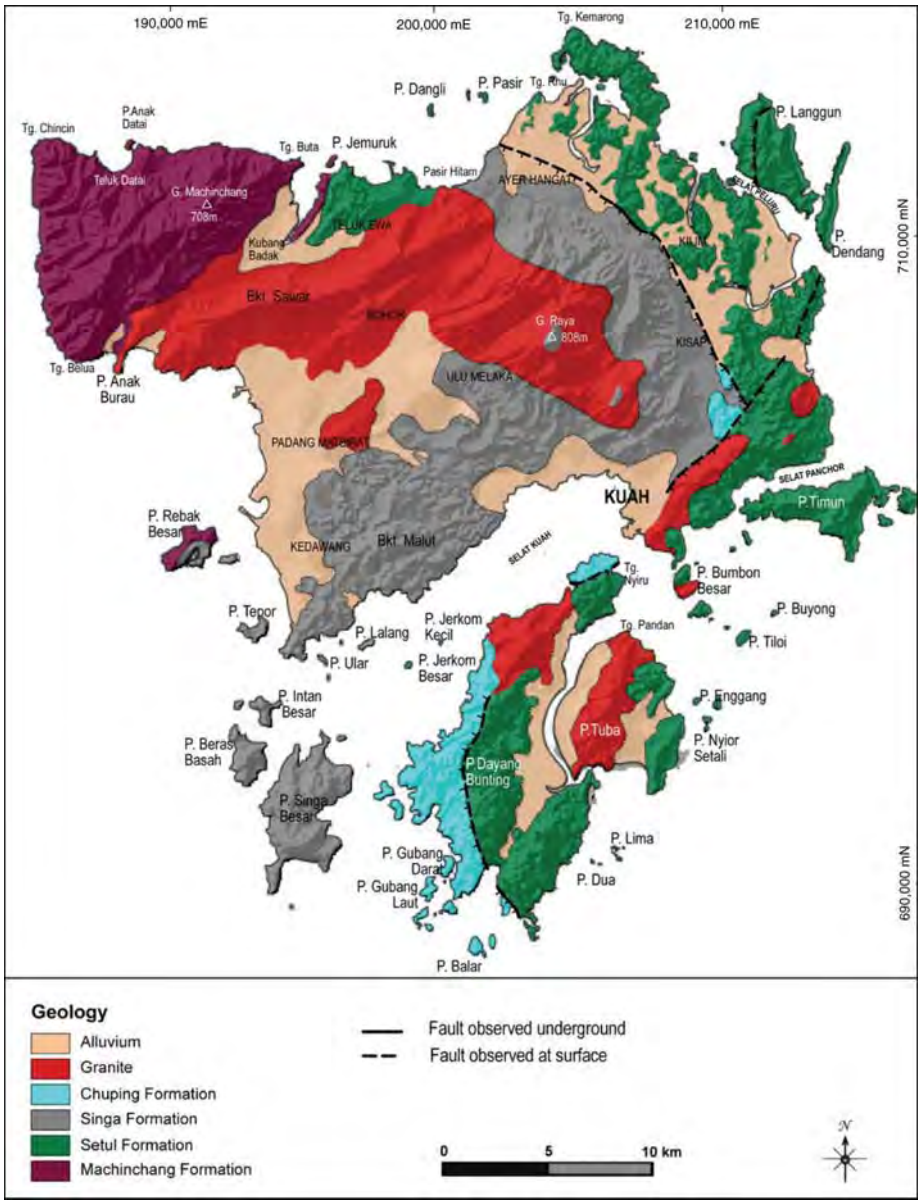

Figure 1: Geological map of Langkawi Islands showing the distribution of the various rock formations in the islands.

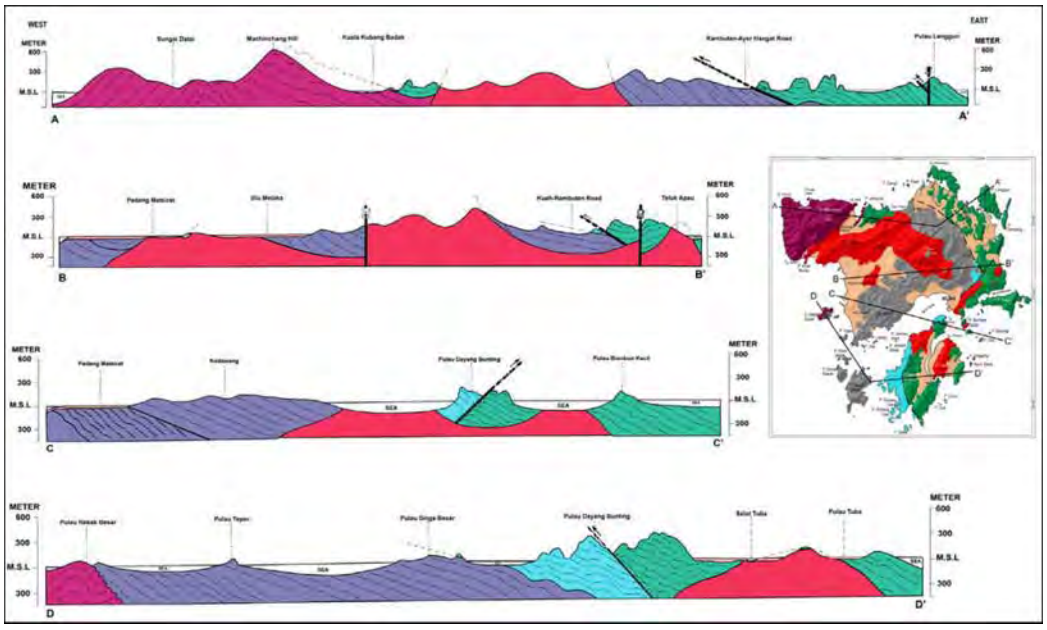

Figure 2: Geological cross-sections showing the general trend of sedimentary succession and the effect of the Kisap Thrust Fault and granite intrusion on the various rock formations in the islands – modified after Jones (1981).

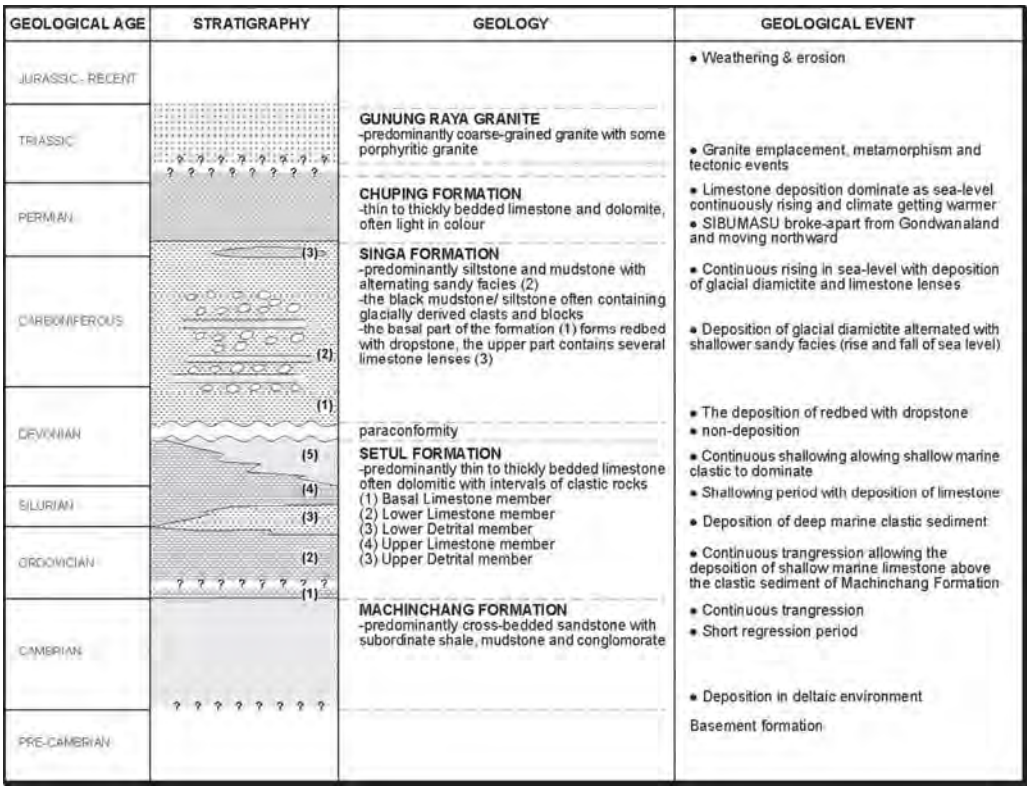

Figure 3: Summary of important Palaeozoic geological history of Langkawi Islands

The Kilim Karst Geoforest Park

Limestone dominates the eastern part of Langkawi Islands, from Tanjung Rhu in the north to Pulau Dayang Bunting in the south. In the north, the Kilim Karst Geoforest Park (Figure 4) is developed on the oldest limestone in the country i.e. the Setul Formation. The Kilim Karst Geoforest Park features breathtaking landscape of nearly vertical karstic hills with pinnacles of various shapes and sizes (Figure 5C). The main factor contributing to the formation of such beautiful karstic landscape is its generally thin beds and flat to very gently dipping attitude with many high angle to vertical faults and fractures as well as its direct exposure to the open sea. On a large scale, the Kilim Karst Geoforest Park is made of several elongated hills and islands with narrow valleys in between, and these valleys are home to one of the best and unique limestone mangrove forests in the world. Many caves with beautiful cave deposits and features were developed within this park including the famous Gua Kelawar, Gua Buaya, Gua Langsir and Gua Cherita. A small fresh water doline-lake was developed at Pulau Langgun. There are many important geosites in this park, among them are:

- several fossil horizons at Pulau Langgun with different fossils that thrived in different palaeoenvironments,
- type section of Setul Formation at Teluk Mempelam, Pulau Langgun,
- highest Malaysian Holocene (circa 7000m.a.) sea level of 23m recorded at Teluk China Mati, Pulau Tanjung Dendang, and
- Kisap Thrust Fault at Belanga Pechah where the older Setul Formation limestones were thrusted over younger Chuping and Singa Formations.

Dayang Bunting Marble Geoforest Park

The Dayang Bunting Marble Geoforest Park (Figure 3) exhibits karstic landscapes developed in the marble of Chuping Formation and limestone of the Setul Formation. Although the pinnacles developed within this park are not as fine as those in the north, this park has some very fine cave features developed in Gua Pasir Dagang, beautiful sea-arches (Figure 5D) and caves such as those at Pulau Lima and Pulau Dua, sea-stacks and other wave-related features. The presence of several beautiful natural land arches at Pulau Lima may suggest that they were probably remains of ancient sea-arches. Tasik Dayang Bunting or Lake of the Pregnant Maiden is the biggest natural fresh water lake in the Langkawi Islands and is thought to be of doline origin. This lake is located in close association with several other dry dolines and natural landscape portraying the outline of a pregnant maiden resting on her back.

Geological Monuments

A geological monument is a large site with several important geoheritages and outstanding landscapes. Several geological monuments have been identified within the Langkawi Geopark. They are:

1. **Pulau Ular Geological Monument** is a small island of the coast of Teluk Baru and Porto Malai carved by selected erosion into several undulating hills with

unique snake-like appearance and well preserved raised ancient wave-erosional platforms (Figure 5E). The island also contains many elaborate sedimentary structures including dropstones of glacial marine origin, ancient sedimentary folds and dense trace fossils.

2. **Pulau Singa Kechil Geological Monument** off the northern coast of Pulau Singa Besar potrays a panoramic limestone column of Chuping Formation resting on muddy rocks of Singa Formation with a geosite for gradual changes between the Singa and Chuping Formations. It gives us a beautiful view of stratified horizons (Figure 5F) beginning with blue water, overlain by black rocks, then green vegetation and capped by white columnar limestone under the blue sky.
3. Other larger geological monuments are the highly fossiliferous **Pulau Langgun Geological Monument** and its adjacent **Pulau Tanjung Dendang Geological Monument** in the northeastern corner of Langkawi Archipelago. The first has many important geosites especially on stratigraphic sections and fossils while the latter has a geosite on extra-ordinarily high ancient sea level and several coastal karstic features including sea-arches and sea-caves.

Langkawi Protected Geosites

The Langkawi Archipelago has at least 90 significant geosites inside and outside these geoforest parks and geological monuments. Some of these geosites contain special rocks and minerals like that of Pantai Pasir Hitam or Black Sand Beach, which is rich in black minerals of tourmaline and illmenite, while others contain special sedimentary structures like the dropstones of Pulau Tepor that indicate an ancient connection between Langkawi and Gondwanaland. The Kilim and Sungai Itau geosites contain well-preserved fossils for dating some of the dropstone horizons to prove the Gondwanaland linkage, while the Kampung Tuba and Kampung Masjid geosites in Pulau Tuba contain uniquely folded granite sills (Figure 5). Thirty of these geosites have been identified at present as among the most highly significant in terms of their scientific value and classified under protected geoheritage sites. Most of these geoheritage sites fall within the geoforest parks, recreational forests and other non-classified PRFs and thus are protected under the Forestry Act by-laws. The mechanism for protection of those outside of these forest reserves will be sought in the future as the development of the Langkawi Geopark progresses. Some of these important geosites are listed in Table 1.

SUMMARY

Looking at the current scenario in Malaysia, the geopark concept, which beside conservation, also stresses on the well being of the local people, seems to be the best alternative for geoheritage conservation. Many local authorities and state governments are inclined towards sustainable development. Hence, the people-centered conservation approach of geopark conservation will certainly be of greater advantage against other conventional conservation concepts that focus on absolute conservation.

The role of geoscientists in the making of a geopark is very crucial as only geoscientists are knowledgeable enough to decide on the heritage value of a particular geological feature as well as the ranks of geoheritage sites. In planning for a good state or national geopark such as the Langkawi Geopark, it is very important for geoscientists to work hand in hand with the local authorities and various other government agencies, particularly those with authority in conservation such as the Forestry Department, Museum Department, Heritage Department etc. It is also very important to package geoheritage sites into various scales for conservation and various geopark trails, preferably incorporating them into the existing tourist nature trails. Lastly, but perhaps most importantly, geopark geoscientists must be able to translate technical geological jargons into very simple informative guides for visitors of various academic backgrounds.

ACKNOWLEDGEMENT

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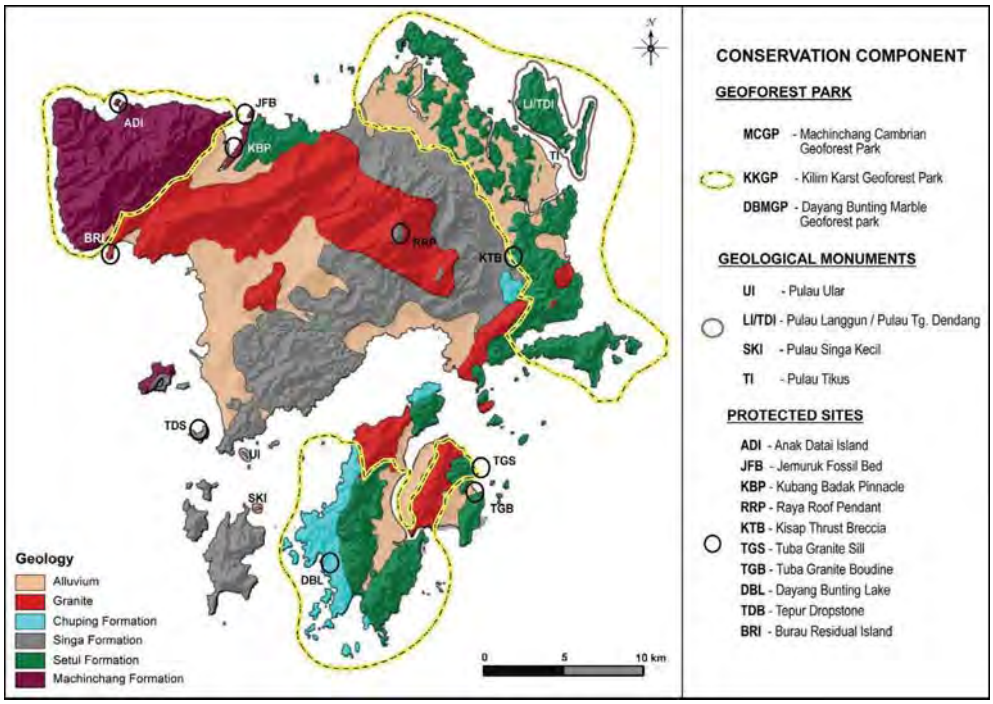

Figure 4: Distribution of Langkawi geoforest parks, geological monuments and some of the protected geosites within Langkawi Geopark.

Figure 5: Some outstanding geological features from selected geoheritage sites of Langkawi Geopark. A) Rare fluid escaped structure at Pantai Pasir Tengkorak. B) Natural fountain at western coast of Machinchang. C) Finely carved pinnacle at Kuala Kilim. D) Amazing natural arch at Pulau Lima. E) Ancient wave abrasion platform at Pulau Ular. F) Limestone column at Pulau Singa Kechil.

Table 1: List of highly significant geoheritage sites of Langkawi Geopark, their geological significance and protection status.

GEOSITES NAME	GEOLOGICAL SIGNIFICANCE	PRESENT STATUS
1. Anak Datai Island	Oldest strata, remnant island, seasonal tombolo	Protected Forest Reserve
2. Temurun waterfall	Thick sandstone sequence, fault, tallest waterfall	Recreational Forest
3. Pantai Pasir Tengkorak sedimentary structure	Excellent sedimentary structure (load cast, flame structure, fluid escapism structure), unique tafoni	Recreational Forest
4. Pulau Jemuruk – Tanjung Buta fossil bed	Oldest fossil (trilobite, brachiopod), trace fossil	Protected Forest Reserve
5. Kubang Badak pinnacle	Unique limestone pinnacle	Uncertain -
6. Pantai Pasir Hitam	Unique black sand (tourmaline, ilmenite)	Uncertain – public beach
7. Sungai Itau – Kilim fossil bed	Cold water fauna (brachiopod, bryozoa), limestone lenses	Uncertain – private properties
8. Gua Cherita	Cave, legendary story	Recreational Forest
9. Kuala Kilim pinnacle	Unique limestone pinnacle, other limestone landscapes	Protected Forest Reserve
10. Gua Kelawar	Tunnels, ancient sea-notches, biodiversity records	Protected Forest Reserve
11. Teluk Mempelam section	Stratigraphic type section, fossils (trilobite, graptolite, crinoid), fossil type locality	Protected Forest Reserve
12. Langgun red bed	Red pebbly mudstone, fossils, spheroidal weathering	Protected Forest Reserve
13. Langgun lake	Fresh water lake, limestone landscapes	Protected Forest Reserve
14. Anak Tikus fossil bed	Fossils (gastropod, cephalopod), fossil type locality	Protected Forest Reserve
15. Teluk China Mati ancient sea level	Record of highest Holocene sea notches, fossils (bivalve, gastropod, coral)	Protected Forest Reserve
16. Burau Island granite	Porphyritic granite, granite erosion features, tor, remnant island	uncertain
17. Telaga Tujuh Waterfall	Porphyritic granite, potholes, waterfall, legendary story	Recreational Forest
18. Gunung Raya roof pendant	Rock diversity (granite, hornfels), mineral (tourmaline), viewpoint, legendary story	Protected Forest Reserve
19. Kisap breccia	Brecciated limestone, thrust fault, legendary story	Protected Forest Reserve
20. Tepor dropstone	Sedimentary structure (dropstone, sedimentary slump), trace fossil	Protected Forest Reserve
21. Pulau Ular abrasion platform	Sedimentary structures (sedimentary slump, dropstone), trace fossil, abrasion platform, sea-notches	Protected Forest Reserve
22. Pulau Singa Kechil transition boundary	Formations boundary section, limestone column	Protected Forest Reserve
23. Pulau Jong limestone	Lithology (limestone, nodular chert), fossil, legendary story	Protected Forest Reserve
24. Pasir Dagang Cave	Lithology (marble), granite-marble contact, cave features	Protected Forest Reserve
25. Dayang Bunting Lake	Doline lake, dry doline, brecciated marble, legendary story	Recreational Forest
26. Pulau Lima sea-arches	Sea-arches, sea-caves, fault	Protected Forest Reserve
27. Teluk Tuba folded sill	Granite-marble contact, granite sills and dykes, folded sills	Protected Forest Reserve
28. Teluk Tuba boudinage	Granite sills, granite boudinage	Protected Forest Reserve
29. Bumbun Island skarn	Granite-marble contact, skarn deposits (garnet, amphibole)	Protected Forest Reserve
30. Gua Wang Buluh	High level cave, wang	Protected Forest Reserve

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