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GEOHERITAGE AS THE BASIS FOR GEOTOURISM DEVELOPMENT: A CASE STUDY IN JELI DISTRICT, KELANTAN, MALAYSIA

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Abstract: Jeli is a district in the state of Kelantan, Malaysia, which blessed with many beautiful geological landforms/landscapes, unique geological phenomena and precious earth materials. They are potential geological heritage of the area. Identification, mapping, and description have been conducted to establish the new inventory of geoheritage sites within the district. Some potential geoheritage sites of Jeli district have been inventoried such as Gunung Reng (mogote hill), Jeli Hot Spring, Pergau Lake (dam), gold deposits in Kampung Kalai, Lata Janggut (cascade), Sungai Rual (river), Lata Renyok (waterfall), Lata Chenai (cascade) and Setir Cave complex. All these spots should be conserved and developed to maintain and protect natural and geological attractions while supporting the geotourism development in the state of Kelantan.

Key words: inventory, geoheritage, geotourism, Jeli district, Kelantan

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INTRODUCTION

Geological heritage (or usually called 'geoheritage') is defined as an applied scientific discipline which focuses on unique, special and representative geosites. This discipline supports the science of geology. Geoheritage is an integral part of the natural heritage which encompasses the special places and objects that have a key role in our understanding of the history of the Earth (its rocks, minerals, fossils, and landscapes).

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Those localities and objects (geosites, specimens in situ and in museum) will give special insight into the evolution of the Earth (ProGEO, 2011). The Geological Society of America (GSA, 2012) defines 'geoheritage' as a generic but descriptive term applied to sites or areas of geologic features with significant scientific, educational, cultural, or aesthetic values. Among the most recent definition of 'geoheritage' is clarified by Brilha (2013) by which geoheritage is defined as particular occurrences of minerals, rocks, fossils, soils, landforms and geological processes with exceptional values.

Many countries from different regions concern about the conservation and development of their geoheritage sites, mainly for the geotourism purpose. In China, geoheritage and geotourism resources are abundant. The research projects on geoheritage and geotourism have been carried out in China since the mid of 1970s and are boosted by the strong and continuous support from the Ministry of Land and Resources and Chinese Academy of Geological Sciences.

With such support, Chinese geologists successfully promote and propose the Geopark concept for geoheritage conservation and geotourism development since 1985, for which China had already established 138 national geoparks, 20 of which have already been accepted as global geoparks. In the process of moving from geoheritage to geopark establishment, China has cooperated closely with UNESCO and has created some categories of geopark, including stratigraphic, paleontological, structural geology, geomorphic, volcanic, glacial, hydrogeological, engineering, and geological disaster. For example, geoheritage sites related to volcanoes and volcanic rocks are mainly found in the West Pacific coastal and Southwest China regions, while those related to paleontology and archeology are primarily found concentrated in the East China region. The Huangshan landforms with granite peaks, peak-clusters, and spheroidal-weathering and the Yuntai landforms of stepped valleys are concentrated in the East China region (Jianjun et al., 2005; Ting & Xun, 2008).

Romania is one of European countries which concern about this issue. One of geoheritage and geotourism resources in the country is the Bucegi Mountains which are located at the easternmost edge of Romania's Southern Carpathians and are almost entirely encompassed within the Bucegi Natural Park. Their overall geological configuration is influenced by the syncline, thus creating a trough bordered to the west and east by steep escarpments. With the growing numbers of tourists in this geomorphosite especially during the summer time, the area is currently regarded as Romania's top mountain destination. However, during the last years, tourism activities generated negative impacts on the environment, such as littering, intense soil erosion, and deforestation. Consequently it is necessary that public awareness should be raised to protect the area (Neches, 2013).

According to Reimold et al., 2005, geoheritage and geotourism can make a major contribution to the poverty alleviation in rural areas of southern Africa, as in many other parts of the developing world. Southern Africa consists of a number of countries including of South Africa and Namibia.

The region reveals a great diversity of geological resources, for example, the coastline of South Africa and its scenic coastal mountain ranges. Namibia is a country that a vibrant tourism industry which is based on natural assets, such as mountain ranges, coastal beauty, desert geomorphology, dune formations, the deep and extensive Fish River Canyon as well as the famous sandstone erosion features called 'Finger of God', which had been a geological icon of the country. Overall, countries in the southern Africa have come close to recognizing the potential values that their geoheritage sites can provide. The countries generally have not realized that their geological resources are potential to be developed and marketed, form another attractive approach to tourism, complementing the existing tourism forms.

In Australia, there has been significant growth in tourism industry since 1970s, with the development of both traditional and emerging markets including of geotourism. Both international and local tourists are attracted to a number of sites where Australia's unique geological heritage is exhibited. Australia's rocks are remarkable with three major groups of rocks – igneous, sedimentary, and metamorphic – are all represented in the country. Australia also has great mineral resources, such as gold, diamond, coal, lead, aluminium, cooper, etc. Australia is well endowed with a number of outstanding geological sites that underpin the country's geotourism. Some examples of geoheritage and geotourism sites include the Great Barrier Reef, Uluru (Ayers Rocks), Shark Bay, Wave Rock, the Remarkable Rocks, the Naracoorte Caves, Sydney Harbour, the Blue Mountains, tessellated pavement, and volcanic landforms (James et al., 2005).

Malaysia also actively conserves and develops its geoheritage resources. Early efforts on geoheritage conservation in Malaysia began in the Third Malaysian Plan (1976-80) through the provision for the need to protect geological monuments and landscapes (Ibrahim, 2004). Systematic efforts toward promoting geoheritage conservation started in 1996 with the establishment of the Malaysian Geological Heritage Group. Afterwards, many research works have been conducted to study and describe many geoheritage sites for conservation and development.



Figure 1. Location map of the study area. Jeli district is situated in the western part of Kelantan state, Malaysia

The state of Kelantan in Malaysia possesses many quite interesting natural and geological attractions. One out of 10 districts in the state namely Jeli district, where this study was conducted, is blessed with beautiful geological landforms/landscapes, unique geological phenomena and precious earth materials, including of hills, caves, rivers, waterfalls, cascades, the hot spring and gold deposits. They are all potential geological heritage of the area. Jeli is situated in western part of Kelantan, strategically located near Kelantan – Perak state border and Malaysia – Thailand international border (Figure 1). This district is approximately 129,680.26 hectare and consists of 3 sub-districts: Jeli, Batu Melintang, and Kuala Balah (MDJ, 2011).

The district is managed by the Jeli District Council. This paper presents the new inventory of potential geoheritage sites in Jeli district. The new inventory is based on the previous listings by Yong, 1989; Amran & Hairul, 1998; Tanot et al., 2001; MDJ, 2011 and complemented by some new proposed potential geoheritage sites through this study. This inventory includes the identification, mapping and description of those geosites. Special attention is given to the possibility of geotourism development by utilizing the potential geoheritage sites of the district.

GENERAL GEOLOGY OF JELI DISTRICT

Jeli district is located in the foot of the Main Range, the backbone of Peninsular Malaysia. The range consists mostly of granitic rocks with several enclaves of sedimentary/metasedimentary rocks. The Main Range granite is located roughly in the west of Kelantan stretching along western of the state up to the state boundary of Perak and Pahang. Based on the general geology of Kelantan (Department of Minerals and Geoscience Malaysia, 2003), Jeli district is generally composed of three rock types: (1) Triassic sedimentary rocks (Gunong Rabong Formation), which consists of shale, silstone, sandstone, and limestone; (2) Permian sedimentary rocks (Gua Musang Formation) which consists of phyllite, slate, sandstone and limestone; and (3) Granitic rocks (acid intrusives). The general geology of Kelantan and Jeli district can be seen in Figure 2.

Geomorphologically, the state of Kelantan can be divided into four types of landscape, they are: (1) Mountainous areas; (2) Hilly areas; (3) Plain areas; and (4) Coastal areas (Tanot et al., 2001). All these types of landscape exist in Jeli district except the coastal areas which only form in the northern part of Kelantan. Mountainous landscape forms in the west and north of the district. This landscape is composed of the Stong Migmatite Complex, the Main Range granite and schist. Some features of this landscape are mountain ridges and mountain valleys. Hilly areas in Jeli are distributed in the foot of mountain ranges. This landscape forms two types of hill, they are isolated hills and elongated hills. The limestone isolated hills usually exposed in the low lying areas, such as Gunung Reng. Elongated hills are ridges but usually lower than mountain ridges. Plain landscape forms in the central and east of the district.

Tectonic activities in Peninsular Malaysia during the Paleozoic and Mesozoic era affect the land mass principally on the formation of faulting and folding. Faulting and folding have been observed as regional as well as localised structures. Localised structures include folding, jointing and faulting in the sedimentary rocks and jointing and faulting in the granitic rocks (Department of Minerals and Geoscience Malaysia, 2003). The dominant structural pattern in Kelantan is along a north-south to northwest-southeast directions. However, the dominant local structures in Jeli district is along northwestsoutheast and northeast-southwest directions.

MATERIALS AND METHODS

Materials of the research include map, photographs and literatures related to geoheritage and the study area.



29

Method used for this study is the inventory of potential geoheritage sites which includes identification, mapping and description of those geosites and their relations to tourism development of the study area. The identification is based on the occurrences of important geological and geomorphological features of the sites. Some geoheritage sites have been identified by previous researchers and some others are the new proposed potential geoheritage sites. The mapping is based on the fieldworks to determine the locations of all those features and their recent geological conditions.

Meanwhile for the description of these geosites, attention was especially given on the scientific value of the sites, but many sites were also chosen because of their aesthetic as the new proposed potential geoheritage sites. The mapping is based on the fieldworks to determine the locations of all those features and their recent geological conditions. Meanwhile for the description of these geosites, attention was especially given on the scientific value of the sites, but many sites were also chosen because of their aesthetic as well as recreational values. A few sites have also their additional cultural value. All the information from the previous literatures and the field were collected for the descriptions of every geosite. The biological aspects (animal and plant life) of the sites will only be mentioned briefly to support the description of the sites.

POTENTIAL GEOHERITAGE RESOURCES IN JELI DISTRICT

There are at least nine (9) potential geoheritage resources have been inventoried in Jeli district, Kelantan, Malaysia. They are Gunung Reng (mogote hill), Jeli Hot Spring, Pergau Lake (dam), gold deposits in Kampung Kalai, Lata Janggut (cascade), Sungai Rual (river), Lata Renyok (waterfall), Lata Chenai (cascade) and Setir Cave complex (see Figure 3 for the location map of each site). Descriptions of each potential geoheritage site in Jeli district are as follow:



Figure 3. Location map of potential geoheritage sites in Jeli district, Kelantan, Malaysia

1. Gunung Reng (mogote hill)

Though the local people designated it as a *'gunung'* (the Malay word for 'mount'), Gunung Reng is not a mount in the true definition but it is actually a karst landform, i.e. a mogote hill, which is an isolated, steep-sided and residual hill towering above the flat alluvial topography (Figure 4). It is located in Kampung Gunong, Batu Melintang subdistrict, along the East-West Highway in the northwestern corner of Kelantan (coordinates: $5^{\circ}43'0''$ N, $101^{\circ}44'38''$ E). The beautiful landscape and some unique features that occur in the area attract visitors to come there. This hill is composed of limestone and metamorphosed limestone (marble) sitting on the intrusive body (granitic rocks) and surrounded by quarternary alluvial deposits. This hill is about 200 m in height and possesses some caves such as Gua Payong and Gua Badak (Yong, 1989), where the main cave goes through the top of the hill. The height of the main cave's mouth is 10 - 12meters, and the length of it is about 21 meters. There are some interesting features inside the caves, such as stalagtites, stalagmites, and colomns/pillars.



Figure 4. (A) Gunung Reng is a mogote hill; (B) The main cave of the hill; (C) Features inside of the main cave; (D) Features in the roof of the cave; (E) Pinnacle structure on the wall of the hill; (F) Dyke (intrusion) and white marble nearby the hill

The caves are the habitats for bats and doves. In the hill, we can see another interesting feature i.e. the pinnacle karst structure as the result of chemical weathering of a limestone hill. Another attraction of the area is Sungai Pergau (the Pergau River, the main and the largest river in Jeli district) flowing through the flat alluvial plain in the south of the hill which significantly beautify the area. In this river, we can observe the outcrop of andesitic dyke (intrusion) and white marble.

This area has become a recreational area, and is also equipped with infrastructures such as a community hall, a playground, public toilets, and food stalls. Some possible activities can be done here such as rock climbing, cave exploration, and hiking. The flat alluvial plain in the area is often used as the camping site. Yong (1989) stated that Gunung Reng is the only geological feature in Peninsular Malaysia featured in a Malaysian postage stamp issued in 1983 to commemorate the opening of the East-West Highway. Because of its beauty and uniqueness, it is proper if we propose Gunung Reng as the landmark of Jeli tourism.

2. Jeli Hot Spring

There is a unique and rare geological phenomenon in Jeli, which is the one and only hot spring in the area, called Jeli Hot Spring. Hot spring is one manifestation of the geothermal where hot water flowing out of our Earth as the form of spring. Jeli Hot Spring is located near the river valley of Sungai Helai (the Helai River) and surrounded by the hilly area in Kampung Bendang Lawa (the Bendang Lawa village), Batu Melintang sub-district, around 1 km from the East-West Highway (coordinates: 5°39'58.5" N, 101°42'51.1" E). There is a rubber plantation near the hotspring. In general, the occurrence of the hot spring in Kelantan is controlled by the geological structure and closely associated with the granite intrusion and magmatic activity in Peninsular Malaysia (Azmi & Azmer, 1998).

The origin of Jeli Hot Spring is still unknown exactly, but from the preliminary study of this hot spring (Azmi & Azmer, 1998), it can be interpreted that this hot spring is associated with the Main Range granite. The hot igneous rock heat groundwater at relatively shallow depths.

geothermal Production from the system may be primarily from sedimentary/metasedimentary rocks and fractured granitic rocks where water can seep throughout the Earth's surface. The water temperature of this hot spring is about 42°C -50°C. The flowing water will be collected in three ponds (Figure 5). Visitors can enjoy the fresh hot water and the natural "sauna" that might give freshness to the body. The content of sulphur in the water is believed to be able to cure some skin problems. There are some infrastructures in the area such as roofed huts equipped with tables and chairs provided for visitors. This hot spring has been developed so far as a tourism spot in Kelantan, but the maintenance of the site is very poor. The accessibility of this site is poor since the road there is very narrow and guite steep.



Figure 5. (A) The recent situation of the Jeli Hot Spring, (B) The vent,
(C) The water temperature measurements show that the temperature of Jeli Hot Spring is around 42°C (min) - 50°C (max)

3. Pergau Lake (Dam)

Though Pergau lake/dam (Figure 6) is an artificial (man-made) lake, it exposes some geological features which have potential geoheritage values. It is located around 30 km from Jeli town, on Mile 16 of the East-West Highway, in Batu Melintang sub-district (coordinates: 5°37′52.3″ N, 101°41′28.3″ E). The area is dominantly composed of granitic rocks. The lake is surrounded by tropical rainforests (Gunung Basor Forest Reserve) in the hilly area. The dam was built in 1990 with its original purpose as a catchment area of Pergau River flow (reservoir) for hydroelectric power generation undertaken by *Tenaga Nasional Berhad (TNB)*, a national electric generating and supplying company.

However, because of the beauty of this dam and its surroundings, its functions can be developed into a tourist destination that offers not only the beauty of this lake, but also a quiet and comfortable environment. There are several small islands scattered in the lake namely Pulau Risda, Pulau Polis, Pulau KESEDAR, and some others where some activities can be organized there. The main visitors' activity here is fishing as there are many common species of freshwater fish. In additions, this lake also contains many *etoks*, a local name for freshwater shells which often become the snack of Kelantan people. Many residents from the surrounding areas, even from outside of Jeli, come to this lake for fishing and netting.

There are some other activities possible to be organized here such as boating, kayaking, swimming, jungle trekking, hiking, training and motivation camp. The lake is equipped with various facilities and infrastructures, including jetty, boats, chalets, dorm as well as hostel. Visitors can choose either want to stay at the floating chalet, dorm or hostel. This lake is governed by *Lembaga Kemajuan Kelantan Selatan* (KESEDAR, the South Kelantan Development Authority).



Figure 6. (A) The peaceful atmosphere of Pergau Lake,(B) The outcrop of granitic rock in the area,(C) The dam was constructed for electric generating and supplying in Jeli area

4. Gold Deposits in Kampung Kalai

Various mineral resources have been discovered and exploited in Malaysia and a large number of them is related to granite intrusions and hydrothermal activities. In Malaysia, gold is the most important metallic mineral that has been mined for years. In Kelantan, gold mining activity has started since the 1920's. Starting from here, mining activities were widely distributed throughout the state from Sungai Galas (the Galas River) and Sungai Pergau (the Pergau River) areas up to the Kalai area along the border of Kelantan State (Malaysia) and Narathiwat Province (Thailand). Kampung Kalai area (Figure 7) is underlain by metasedimentary rocks, which are close to the granite intrusion. Prior to 1923, prospecting and mining in the Kalai area were carried out mainly for gold (MT-JGSC, 2006). Kampung Kalai is located in Batu Melintang sub-district. Gold mineralization zone in Kampung Kalai is interpreted to be affected by the Kalai Fault, a fault along the upper part of Sungai Tadoh (the Tadoh River) trending north-south direction. The occurrence of gold deposits is very rare, so it is very valuable for us to be able to see the gold directly in the field.

Based on the interview with some local villagers in Tadoh River area, they said that Kampung Kalai is a historical gold mining site. They have ever discovered ex-gold mining site, mining machine, Chinese pottery and crockery since 1960. They also believe that the gold mining operation was started since the period of British colonial. In addition, according to the villagers, they have discovered an old and abandoned tunnel which is about 20 meter long and has been used for mining gold since a long time ago. The tunnel is now fulfilled with bushes and wild animals. There was a private company using mining machine 10 years ago. At present, the activity has stopped due to less reserve of gold deposits (not economic any more).

However, local people are still working for gold by a traditional way of panning. Most of the villagers carry out the panning activity after finishing their main job, i.e. rubber tapping. They also said that they will do the panning more during the rainy season since they cannot do the rubber tapping then.



Figure 7. (A) Gold panning activity by locals in Tadoh River, Kampung Kalai,(B) The outcrops of granite and white marble in the river,(C) Gold grains obtained from the panning activity

5. Lata Janggut (waterfoll)

Lata Janggut (coordinates: 5°40'9" N, 101°46'12.5" E) is one of some enchanting cascades in Jeli district. It is located in Kampung Lata Janggut (the Lata Janggut village), Batu Melintang sub-district, around 15 kilometers from Jeli town. It is part of 34

the Long River, a tributary of Pergau River, and situated within the Gunung Basor Forest Reserve (Figure 8). The formation and development of the Long River is influenced by a major fault, i.e. the Long Fault which trends northeast – southwest along the river. This cascade is formed on the exposed body of granitic rocks (batholith). Going through the upper of this cascade, we can find a waterfall as high as 5 meters and the water current here is relatively swift. The water here is very clean and cool. However, visitors should be careful when they visit this area since there are some slippery and deep spots here.

There are a few pothole structures in some parts of the igneous body. The downstream of the cascade is shallow and looks like a swimming pool. Swimming, jungle trekking, and barbecues are some main activities in the area. Quite spacious parking lot and cemented walkway are the only good condition facilities here, whereas other facilities are very poor.



Figure 8. (A) The cascade is composed of intrusive igneous rock (granitic rocks), (B) A waterfall in Lata Janggut, (C) The flow of Sungai Long (the Long River)

6. Sungai Rual (River)

Sungai Rual (Figure 9) is a river flows from Kampung Sungai Rual to Kampung Baru Sungai Rual before entering the Pergau River as the main river in Jeli. This river extends from the longitude of $101^{\circ}47'30.0$ "N to $101^{\circ}51'.0$ "N and the latitude of $5^{\circ}39'0$ "E to $5^{\circ}41'25.0$ "E. Some geomorphological features occur along the river such as cascade and rapids, meanwhile geological features include fault, joints, and magma mixing evidence. Rual river area is dominantly composed of granitic rocks and topographically surrounded by hilly areas.

The hilly areas surrounding the river give a magnificent view that make the area more interesting and enjoyable to be explored. The cascade here has originally clean water, but it will be cloudy after the heavy rains due to sediments transported through the river. Sungai Rual is suitable to visitors for swimming. Visitors so far come from the nearby villages. Kampung Sungai Rual is a settlement for indigenous people of Jahai tribe which is located around 22 km from Jeli town. The combination between natural and cultural resources of this area becomes a unique attraction to visitors.

7. Lata Renyok (waterfall)

Seri Bongor waterfall or more often called as the Lata Renyok waterfall (Figure 10) is a beautiful waterfall which is located in Kampung Renyok (the Renyok village), Kuala Balah sub-district, nearby Jeli – Dabong Road (coordinates: 5°34'47.1" N, 101°52'28.5" E). This waterfall is a part of the Renyok River, a tributary of Pergau River. This waterfall is around 100 meters long and 8 meters high, and surrounded by the forest (Gunung Basor Forest Reserve) in the hilly area.

The beauty of this waterfall comes not only from the waterfall itself and its surrounding area, but also from the rock there. Combination between the bright and dark-coloured rocks has made this waterfall more interesting. This geosite is a part of the Stong Migmatite Complex, which represents a cluster of rocks that are unique and rarely found in Malaysia (Tanot et al., 2002a).

According to Tanot et al., 2002b, this waterfall is composed of leucogranite with the enclaves of metasedimentary rocks. The formation of this geosite was affected by both endogenic and exogenic processes. The uplifting has created the waterfall, and the subsequent weathering and erosion processes occurred on the fractured rocks have produced some geomorphological features in the waterfall area such as stream/channel, cascade, rapids, pond, and river terrace. The Fractures/cracks here are intensive and systematic, and trending west – east direction which is parallel to the river flow direction. The compression has produces some mini folds, otherwise the continuous stretching (extension) has formed boudinage structures (boudins).



Figure 9. (A) A cascade in Rual River; (B) The rapids, (C) The panoramic view of the river area which is surrounded by hilly area, (D) A magma mixing evidence shows the different kinds of granitic rocks, (E) Some parts of this river has clear water and it is suitable for swimming 36

We can also observe a lot of veins within the rocks, mainly quartz veins. This geosite can be accessed through Jeli - Dabong Road. Visitors have to pass through the village and will find the rubber plantation before reach this waterfall. There is a mini hydroelectric station in the area which is operated by TNB that generates electricity from the waterfall and supplies it to nearby residents. Based on an interview with the engineer from TNB in the site, this mini station can generate 900 kilowatt (kW) and 3,300 Volt electric power. Other than electricity, residents in this village can also get the clean water directly from the waterfall. Due to the natural beauty of the area, this waterfall is quite popular among the locals in Jeli. There are several facilities provided in this area such as multi-purpose hall, praying room, public toilets, gazebos, and parking lots, however, their management and maintenance are very poor. Some activities are possible to be done here such as hiking, swimming, and fishing. However, visitors must be careful if they come to this waterfall since some spots here are relatively deep and the current will be swift mainly during the rainy season.



Figure 10. (A) Lata Renyok waterfall, (B) Some systematic fractures and a channel in the area, (C) A boudinage structure, (D) The mini hydroelectric station, (E) Fishing is an activity usually done by locals in the area

8. Lata Chenai (waterfall)

Another interesting cascade in the district is Lata Chenai (coordinates: 5°28'48.1" N, 101°52'33.8" E), also known as Lata Chenor or Lata Chenang by locals. This cascade (Figure 11) is a part of Sungai Terang (the Terang River), a tributary of Pergau River. It is situated in Kampung Relak (the Relak village), Kuala Balah sub-district, nearby Jeli – Dabong Road. It has several rapids and cascades.

Lithologically, like Lata Renyok waterfall, this cascade is also a part of the Stong Migmatite Complex (Tanot et al., 2002a). Based on the field observation,

approximately 90% of this geosite area is composed of porphyritic granite. The porphyritic granite here is light in colour, i.e. gray and pink (because of the existence of alkali feldspar as the phenocryst), with the coarse phenocryst. Tanot and Ibrahim (2004) stated that the rock diversity in the site includes biotite-hornblende schist, porphyritic granite, microgranite, leucogranite, syenite, and granite. The uniqueness of this cascade is the existence of many pothole structures (potholes) of different sizes in the large body of granitic rocks.



Figure 11. (A) A rapid in Lata Chenai cascade, (B) A close-up view of porphyritic granite, (C) A big pothole structure, (D) Joints, (E) Some fault lines, (F) The downstream area of the cascade which is shallow and suitable for swimming

Other geological features include joints and faults. In addition, veins can be seen in some parts of the cascade. This geosite is still in the remote area and surrounded by the tropical rainforest (Gunung Basor Forest Reserve). The river flow at the downstream is very wide but is not so deep that it is suitable for swimming. Fishing is another possible activity can be done here. Unfortunately, the accessibility is very poor where the road to this site is very narrow and in poor condition. No facility provided in this area.

9. Setir Cave (Gua Setir) Complex

The Setir Cave (coordinates: 5°39'38.88" N, 101°55'31.8" E) is a large cave complex located in the eastern part of Jeli district, near Kampong Pasir Dusun. We call it as a cave complex because it consists of many caves inside and decorated by complex structures. According to locals, there are around 40 caves combined to form the Setir Cave complex. This cave complex is composed of limestone and forms an elongated limestone hill. We can observe many cave structures inside, such as stalagtites, stalagmites, columns (pillars), dripstone, etc (Figure 12). The caves become the home for bats, so we can see bat's droppings scattered everywhere inside of the cave. Local people usually collect the bat's dung for the fertilizer.



Figure 12. (A) A passageway of the cave, (B) A column, (C) The limestone hill where the Setir Cave complex occurs, (D) Structures inside the cave, such as the stalagtite, (E) The dripstone structure

GEOHERITAGE VALUES AND GEOTOURISM DEVELOPMENT

Resulted from geological processes, geological heritage is diverse in form and size that have geoheritage values including of scientific/educational, aesthetical, recreational, and cultural values. Geoheritage resources have also different levels of significance, such as international, national, state to district levels. Table 1 presents the existence of geoheritage values of some potential geoheritage sites in Jeli district and their respective significance level.

| No. | Potential Geoheritage sites | Scientific/ value | Aesthetical value | Recreational value | Cultural value | Significance level | |
|-----|--------------------------------|----------------------|----------------------|--------------------|-------------------|-----------------------|--|
| 1. | Gunung Reng | + | + | + | + | State | |
| 2. | Jeli Hot Spring | + | + | + | - | Local/District | |
| 3. | Pergau Lake | + | + | + | - | State | |
| 4. | Gold deposits in Kg. Kalai | + | - | + | + | State | |
| 5. | Lata Janggut | + | + | + | - | Local/District | |
| 6. | Sungai Rual | + | + | + | + | Local/District | |
| 7. | Lata Renyok | + | + | + | - | State | |
| 8. | Lata Chenai | + | + | + | - | State | |
| 9. | Setir Cave complex | + | + | + | - | Local/District | |

Table 1. The geoheritage values and significance level of some potential geoheritage sites in Jeli district

Note: + exist - not exist

One of the utilization of geoheritage sites is for geotourism development. Geotourism is a new concept for tourism development all over the world. According to Newsome and Dowling (2005), geotourism in the field of geology is defined as a kind of tourism based on geological features which are potential to attract visitors to come and enjoy them. Through geotourism we hope a better understanding of the Earth can be achieved so that its geological attractions can be acknowledged.

Jeli district possesses many potential geoheritage resources which in the same time also become the attractions of this area. All these resources are going to be utilised to stimulate the geotourism development of the district. A geoheritage site should be so attractive that visitors and geotourists are interested in visiting the area. The sites should also be provided with a space, support, tools, facilities and infrastructures to be able to organize tourism and recreational programmes and activities.

Jeli is the gateway to the state of Kelantan from the West Coast of the Peninsular. Based on direct observations in all geotourism sites in Jeli, mostly visitors (tourists) are local people of Jeli district and people from surrounding areas. Their main motivation for visiting these geotourism sites is to enjoy the beautiful landscapes and unique features. Some locals also come to some sites for fishing and netting in the lake and rivers. Other visitors are those who are travelling across the country on the East-West Highway and stop in the sites close to the highway to take a rest and enjoy the beautiful and unique views such as Gunung Reng, Pergau Lake, Jeli Hot Spring and others. Lecturers and students of geoscience/geology from local universities visit the sites routinely for teaching and learning as well as research works.



Figure 13. (A) Rock climbing is possible to be conducted in Gunung Reng hill, (B) Cave exploration in Setir Cave complex, (C) Camping activity in Gunung Reng area, (D) Gold panning in Tadoh River, Kampung Kalai, (E) Hiking along the Lata Janggut area, (F) Boating in the Pergau Lake

Some possible geotourism programmes and activities which can be conducted in potential geoheritage sites of the district among others are rock climbing, cave exploration, camping, hot water bathing, gold panning, jungle trekking, hiking, swimming, boating, kayaking as well as fishing (Figure 13). Table 2 shows the possible programmes and activities in each potential geoheritage site of Jeli district.

| N 0. | Programmes and activities Potential Geoheritage sites | Rock climbing | Cave exploration | Camping | Hot water bathing | Gold panning | Jungle trekking | Hiking | Swimming | Boating | Kayaking | Fishing |
|---------|--|---------------|------------------|--------------|-------------------|--------------|-----------------|--------------|--------------|--------------|--------------|--------------|
| 1. | Gunung Reng | \checkmark | \checkmark | \checkmark | - | - | - | \checkmark | - | - | - | - |
| 2. | Jeli Hot Spring | - | - | - | \checkmark | - | \checkmark | \checkmark | - | - | - | - |
| 3. | Pergau Lake | - | - | \checkmark | - | - | \checkmark | \checkmark | \checkmark | \checkmark | \checkmark | \checkmark |
| 4. | Gold deposits in Kg. Kalai | - | - | - | - | \checkmark | - | - | \checkmark | - | - | - |
| 5. | Lata Janggut | - | - | \checkmark | - | - | \checkmark | \checkmark | \checkmark | - | - | - |
| 6. | Sungai Rual | - | - | - | - | - | \checkmark | \checkmark | \checkmark | - | - | - |
| 7. | Lata Renyok | - | - | - | - | - | - | \checkmark | \checkmark | - | - | \checkmark |
| 8. | Lata Chenai | - | - | - | - | - | \checkmark | \checkmark | \checkmark | - | - | \checkmark |
| 9. | Setir Cave complex | \checkmark | \checkmark | \checkmark | - | - | \checkmark | \checkmark | - | - | - | - |

 Table 2. Some possible geotourism programmes and activities in potential geoheritage sites of Jeli district

Note: ✓ possible - not possible

There is no research work on number of tourists visit geotourism sites in Jeli so far, however, based on field observations during several days in each site, around 15 to 20 visitors come to the sites daily. The number of visitors increases during the weekends and holidays. Other than geological heritage, Jeli is also a quite unique district in term of cultural heritage, since there is a settlement for the indigenous people (orang asli) of Jahai tribe located in Kampung (village) Sungai Rual. The existence of this indegenous people has so far become another attraction for visitors (Figure 14).



Figure 14. (A) The settlement of the aboriginal people in Kampung Sungai Rual, Jeli, (B) Some visitors with some kids of Jahai tribe in the village

Many visitors come to the area to study about the indigenous people or to organize programmes with the people. Most of the potential geoheritage and geotourism sites in the district, however, face several problems or constrains, such as low level of accessibility, lack of facilities and infrastructures, and problems on management, maintenance, and cleanliness.

Geotourism programmes and activities should contribute to the conservation and development of geoheritage sites. Programmes and activities that we will organize in a geoheritage site should be in line with the protection of the area, and combined with the promotion of sustainable development. Geotourism is also expected to encourage and empower local community to improve their welfare while conserving and developing their area. There should be a collaboration among the authorities/governments, private sectors, NGOs, educational institutions/universities, and local community towards this planning.

CONCLUSION

Geoheritage is one of the beneficent branches of the natural heritage which needs to be conserved and developed. Some geosites in Jeli district have been inventoried recently as potential geoheritage sites, namely Gunung Reng (mogote hill), Jeli Hot Spring, Pergau Lake (dam), gold deposits in Kampung Kalai, Lata Janggut (cascade), Sungai Rual (river), Lata Renyok (waterfall), Lata Chenai (cascade) and Setir Cave complex. Geoheritage resources in Jeli district can contribute for geotourism development through some possible programmes and activities such as rock climbing, cave exploration, camping, hot water bathing, gold panning, jungle trekking, hiking, swimming, boating, kayaking as well as fishing. The following research works should be done for the establishment of all these potential geoheritage sites including of their classification, characterization, assessment, evaluation as well as promotion.

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