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Study on Geoheritage and Water Quality of Pos Hendrop Hot Spring, Lojing Highlands, Kelantan, Malaysia

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Abstract

Pos Hendrop hot spring is one of the hot springs in Lojing Highlands, in the state of Kelantan, Malaysia. The hot spring is located within the Main Range Granite and is among the hottest hot spring in Malaysia. The aim of this paper is to discuss geoheritage potentials and water quality of this hot spring. Desk study was carried out by reviewing some literatures related to the topic and the study area. Field works were organized in January and August 2014 to collect data, samples, and photographs. This site has geoheritage values such as scientific, aesthetic, recreational, functional, and economic values. The in-situ water quality analysis which was conducted in 2014 during the dry and rainy seasons in Kelantan (January and August 2014) generally shows that the water quality in the measurement points of the hot spring area ranges from "Class IIB" to "Class V" based on the Interim National Water Quality Standard (INWQS) for Malaysia. This hot spring also shows a good potential to attract the interests of geoscientists and general public to visit the area. Some specific tourism and recreational activities can be done in the site such as eggs boiling, bathing and heating, hot spring therapy, and skin treatment. It is recommended that this hot spring should be conserved and developed properly as a potential geoheritage site and for a sustainable geotourism development in Lojing Highlands.

1. Introduction

Geological heritage (or usually called 'geoheritage') is defined as an applied scientific discipline which focuses on unique, special and representative geosites. Geoheritage is also 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). 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.

One of the utilizations of geoheritage sites is for geotourism development. 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.

The state of Kelantan in Malaysia possesses many unique and interesting geological sites and features which have geoheritage and geotourism potentials. One of them is hot springs. The state has

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some hot springs which are distributed in some of its districts. Most hot springs in the state are located in Lojing Highlands, including the Pos Hendrop hot spring which becomes the focus of this study. Lojing Highlands is located at the foot of the Main Range (also called the Titiwangsa Range), and is covered with highland tropical rainforest which is rich of flora, fauna, and local communities who live harmoniously with the nature (Adriansyah et al. 2014). Lojing is so far well-known as the home for Rafflesia kerri (Zulhazman Hamzah et al. 2010; Siti Munirah 2012), one of the biggest flowers in the world and the largest species in Peninsular Malaysia. The Rafflesia has become the icon and the main tourism attraction of the highlands. If Rafflesia can be considered as the flagship attraction of the highlands (Zulhazman Hamzah et al. 2010), hot springs in Lojing should be assumed as the complementary attraction which provides added value for tourism to the area.

Although there is no standard definition of hot spring which is universally accepted, hot springs can be generally defined as a manifestation of the geothermal where hot water flowing out of the Earth in the form of spring. Thompson and Turk (2007) simply defined hot springs as hot groundwater which naturally flows to the surface. Sen et al. (2010) defined hot springs as springs where the temperature of water lies significantly above the mean of annual air temperature of that region. At rainy seasons, water descends behind it and forces the new heated water to ascend along the fault-line to surface as a hot or warm spring. A hot spring is potential to become a geoheritage resource since it possesses some geoheritage values such as scientific, aesthetical, recreational, and so on. A hot spring is also potential to be promoted as a geotourism site, since it can attract people to visit the site and enjoy some specific activities by using the fresh hot water such as boiling eggs, experiencing the natural "sauna" bath that might give freshness to the body, and the skin treatment. In addition, a hot spring can also attract the interest of geoscientists to study their occurrences and other experts to develop the site.

There are only very few previous research works have been conducted in the Pos Hendrop hot spring. Azmi Ismail and Mohd Azmer Ashari (1998) have conducted a qualitative study on 15 hot springs in Kelantan, including of the Pos Hendrop hot spring (they have indicated this hot spring as "HS10" for their research purpose). According to them, this hot spring is one of the hot springs that has a high flow rate (0.05-4.44 m3/hour) and strong sulphur odor. They also stated that the occurrence of the hot spring in Kelantan is generally controlled by the geological structures and closely associated with the granite intrusion and magmatic activity in Peninsular Malaysia. Most of the hot springs are known so far located either near the granite or along the major faults or zones of the joint.

The present paper discusses the geoheritage and geotourism potentials of the Pos Hendrop hot spring. This study is supported by the in-situ water quality analysis of the hot spring during the dry season and the rainy season in 2014.

1.1. Study Area

The Pos Hendrop hot spring (coordinates: 040 42' 35.19" N (latitude), 1010 34' 3.9" E (longitude) and altitude: 272 m above sea level) is located in Lojing Highlands, within Lojing sub-district, in the state of Kelantan, Malaysia. Strategically, the hot spring is situated around 30 km from Cameroon Highlands, a famous tourism destination in the neighbouring state of Pahang, or about 70 km from Gua Musang town, the main town in the south of Kelantan. It is around 300 m from the Gua Musang – Cameroon Highlands Highway and is close to the Beruk River and the Sungai Berok Forest Reserve (Fig. 1, Fig. 2). In the vicinity of the hot spring, there is a settlement of aboriginal people (orang asli) of Temiar ethnic which is called Kampung (village) Hendrop (also known as Pos Hendrop). The hot spring is considered as the hottest spring in Kelantan with the water temperature can reach more than 70°C.

The site has a good accessibility since the authority has built a paved road from the highway (Gua Musang – Cameron Highlands Highway) to the site. Visitors can come by car and park in the parking lot provided in the area which is close (a walking distance) to the hot spring. The hot water flows naturally and continuously from the two source points (the main and the secondary vents) to the lower elevation area. The water then enters four newly built, cemented ponds before finally discharges into the nearby river, the

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Berok River, which is located around 100 m in the east of the main vent (Fig. 3, Fig. 4).

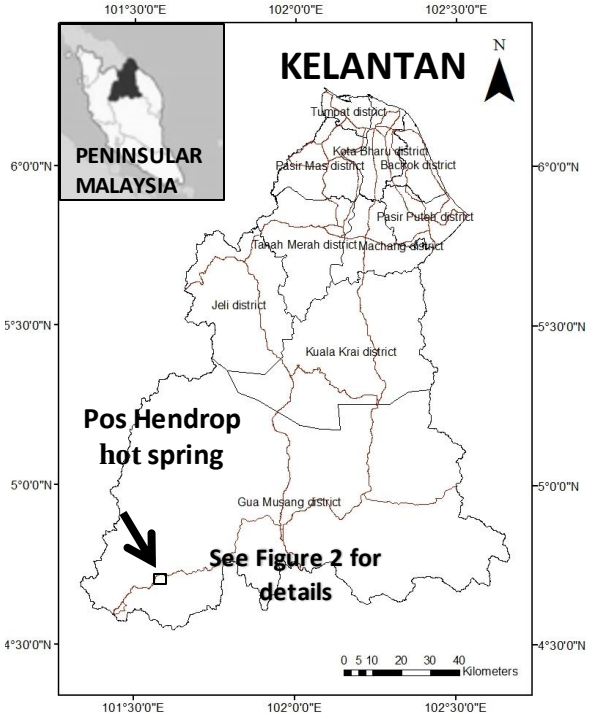

Figure 1: Location map of the Pos Hendrop hot spring area.

Figure 2: The satellite image of the Pos Hendrop hot spring area and its vicinity (Source: Google Earth 2014).

2. Materials and Methods

Materials of the research include maps (the location map and the geological map) and photographs, meanwhile some standard geological equipment such as GPS, compass, hammer etc. and water quality equipment (YSI 556 Multiparameter) were used during the field works. The methods used for this study were generally divided into two, i.e. desk study and field study. Desk study required efforts to perform literature study about the topic and the study area. Meanwhile, field study was conducted through two-phase field investigations, where the first field investigation was carried out during a scientific expedition in Lojing Highlands organized by Faculty of Agro-based Industry and Faculty of Earth Sciences, Universiti Malaysia Kelantan in January 2014. The first in-situ water quality measurements were also conducted during the first field investigation (in January 2014, the dry season in Kelantan) on three measurement points (the spring's main vent, the flowing water area, and a collecting pond). The work was continued through the second field investigation in August 2014 where the second in-situ water quality measurements were also carried out during the rainy season in the state. After the finding of the secondary vent and the construction of four collecting ponds, eight measurement points (the main vent, the secondary vent, the flowing water area, four collecting ponds, and the water discharge point near the river) have been chosen to investigate the water quality of this hot spring. Some photograph shoots were also conducted during the expedition and the field work.

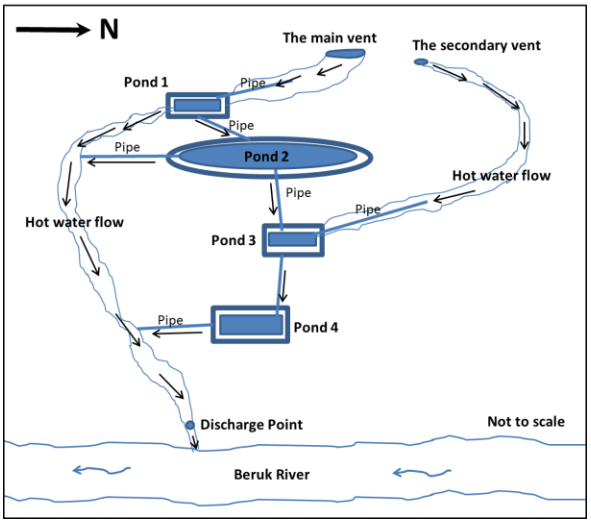

Figure 3: A sketch of the Pos Hendrop hot spring area and its features.

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3. Results and Discussion

3.1. Geomorphology of the Area

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 Unjah et al. 2001). Lojing Highlands of southern Kelantan is a part of the Main Range, the "backbone" of Peninsular Malaysia and the most prominent mountain range in the Peninsula. The topography of mountainous areas (>300 m) dominates the highlands. Other types of landscape also exist in Lojing Highlands except the coastal areas. Mountainous landscape in Lojing is composed of the Main Range Granite; the hilly area forms the elongated hills which are ridges but usually lower than mountain ridges; and plain landscape forms in between of the hilly and mountainous areas.

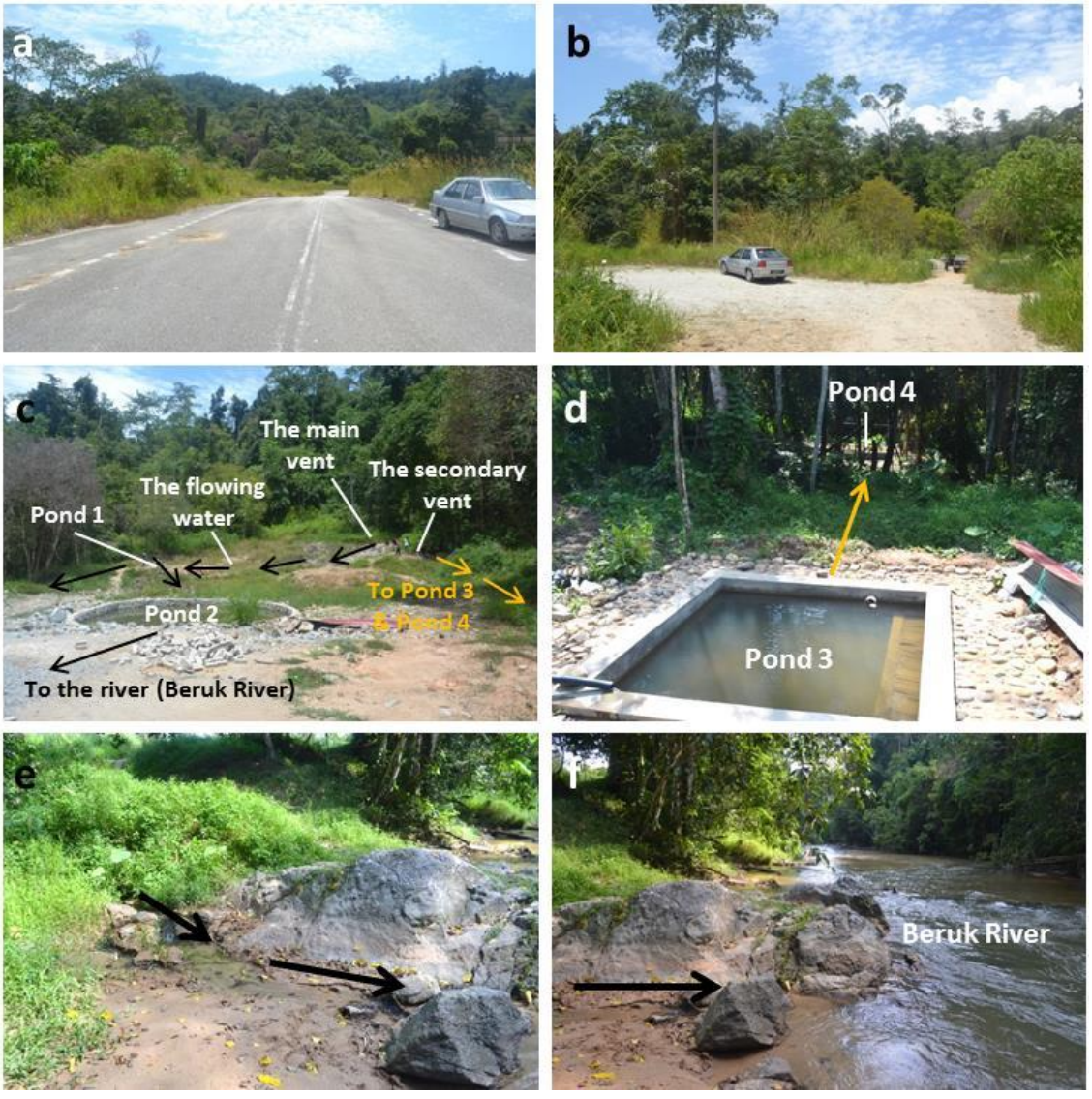

Figure 4: The recent situation in the Pos Hendrop hot spring area. The arrows in the figures show the flow of the hot water. (a) A paved road connects the main road to the site; (b) A simple parking lot in the site; (c) Some important features within the Pos Hendrop hot spring; (d) Some collecting ponds in the site; (e) The final flow of the hot spring is the water discharge to the river (Beruk River); (f) The meeting point between the water discharge and the river.

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Based on the field observations, the Pos Hendrop hot spring is located in the topography of a relatively plain area and surrounded by the hilly area (Fig. 5). This hot spring is located near the Beruk River which flows around 150 m in the east of the hot spring.

Figure 5: General topography of the Pos Hendrop hot spring area where the hot spring is located in a relatively plain area surrounded by the hilly area.

3.2. Geology of the Area

As mentioned early, the study area is situated in Lojing Highlands, which is a part of the Main Range. This range consists mostly of granite with several enclaves of metasedimentary rocks (Raj 2009). The Main Range Granite in Kelantan is located roughly in the west of the state stretching along western Kelantan up to the state boundary of Perak and Pahang, and the international boundary of Malaysia – Thailand.

Che Abdul Rahman and Kamal Roslan Mohamed (2001) reported that the distribution of igneous rocks in Kelantan is in the west and east borders of the state (the Main Range Granite and the Boundary Range Granite) and also occurs in the centre of the state (Fig. 6a). Department of Minerals and Geoscience Malaysia (2003) also stated that the granitic rocks in Kelantan can be divided into two main bodies: the Main Range and the Boundary Range. The Main Range Granite is generally of a Late Triassic age, between 200 and 230 million years ago.

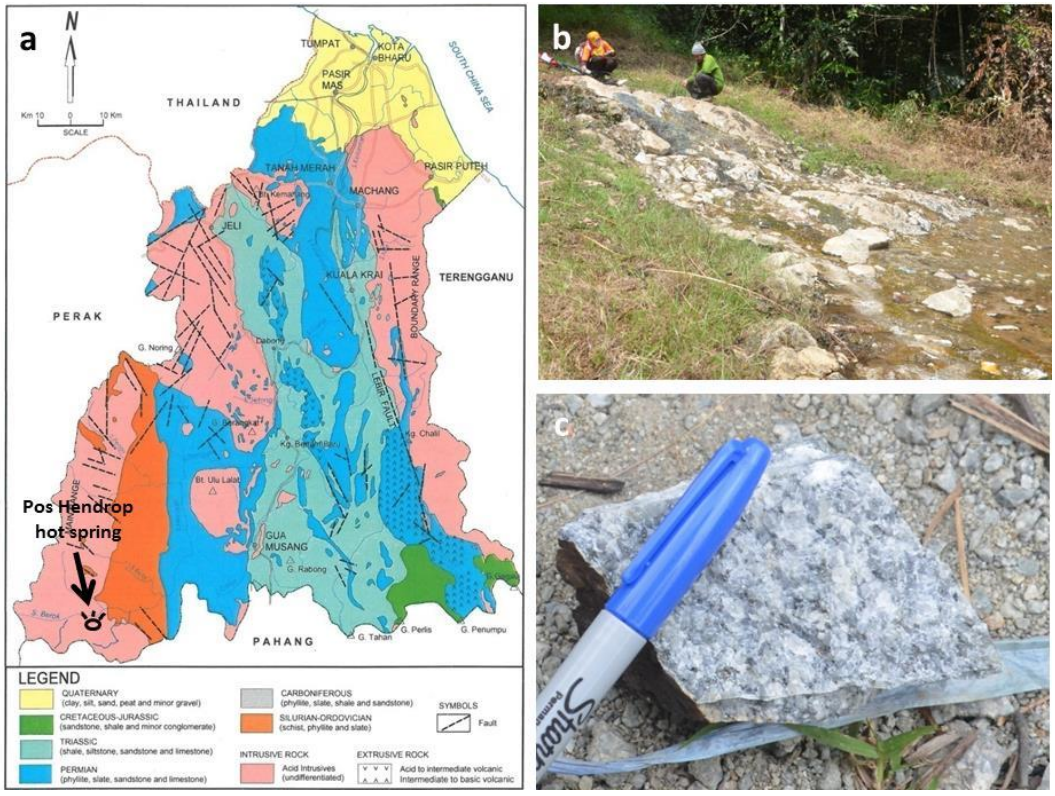

Figure 6: The Pos Hendrop hot spring area is monotonously composed of granite of the Main Range. (a) The general geological map of Kelantan (Department of Minerals and Geoscience Malaysia 2003). The Pos Hendrop hot spring is a part of the Main Range Granite; (b) Granite body in the hot spring area; (c) A fresh hand specimen of granite from the area.

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Geologically, the Pos Hendrop hot spring is located within the Main Range Granite. There is no sedimentary and metamorphic rocks found in the hot spring area. The granite outcrop in the study area can be found in a large granite body. The observation on granite was conducted to the outcrop (Fig. 6b) and the hand specimen (Fig. 6c). The rock is very light gray, usually weathered to dark gray, and phaneritic texture. The rock consists of quartz, plagioclase (white), and biotite (black).

The hot water exits from the cracks or openings in the granitic rock (there are two source points or vents). The gas of hydrogen sulphides (H_2S), which emerges from the vents, will produce bubbles within the water. Since this hot spring has the hotter water compared to other hot springs in the highlands and in the state, so the more minerals (mainly sulphides) that will be able to remain dissolved in the water, and the more the sulphurous rotten eggs smell (the odour) will be produced to the environment.

3.3. Geoheritage Values

The Pos Hendrop hot spring is a unique and special feature that plays an important role in our understanding of the dynamic of the Earth. This locality possesses some exceptional values such as scientific, aesthetic, recreational, functional, and economic. Therefore, this hot spring has a potential as one of geoheritage resources especially for Lojing Highlands as well as for the state of Kelantan. Table 1 presents the identification of some geoheritage values of the Pos Hendrop hot spring.

Table 1: The geoheritage values of the Pos Hendrop hot spring

No.	Geoheritage Values	Remarks
1	Scientific	- The formation of hot spring (including of factors controlling the hot spring, such as rock and geological structure) - Water quality analysis of the hot water - Potential uses of hot spring - etc.
2	Aesthetic	The hot spring is nestled in a green environment with the lush forest reserve and hills, and provides a clear, cool, and fresh mountainous air.
3	Recreational	It can attract people to visit this serene site and enjoy some specific recreational activities, such as boiling eggs, bathing and heating, as well as jungle trekking and hiking (to the highland forest).
4	Cultural	-
5	Functional	Visitors can enjoy egg boiling activity and some other activities. The development of this site and the proper treatments of this hot spring will enable visitors to enjoy bathing and heating, hot spring therapy and skin treatment, and possible geothermal energy in the future.
6	Economic	The area is potential to be developed as a tourism destination in Lojing Highlands and Kelantan that can generate income to the local community and the state.

3.4. In-Situ Water Quality Analysis

The in-situ water quality measurements were conducted in this site to examine some physical and chemical parameters of the hot spring during the two different seasons in the state of Kelantan in 2014, i.e. the dry season in January and the rainy season in August. Some physical parameters were measured such as pH, temperature, total dissolved solid (TDS), suspended solid (SS), and salinity by using YSI 556 Multiparameter. Some chemical parameters i.e. conductivity and dissolved oxygen (DO) were also measured by using the same equipment.

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The first-phase in-situ water quality measurements were conducted in the dry season (January 2014) where three measurement points have been chosen, they are the spring's main vent, the flowing water area, and the collecting pond (Fig. 7). At that time, the site has not yet been started to be developed and there are still no other ponds except this pond (called as "pond 2" for this study). After the finding of the secondary vent and the construction of four collecting ponds by the authority, eight measurement points have been chosen for the second-phase in-situ water quality measurements which were carried out in the rainy season (August 2014). Those points are the main vent, the secondary vent, the flowing hot water area, four collecting ponds, and the discharge point near the river (Fig. 8).

Figure 7: Three selected points for the first-phase in-situ water quality measurements of the hot spring. (a) The water quality parameters were measured at the main vent, the flowing water area, and the collecting pond (now become "pond 2"). There is only a vent and a pond then; (b) Water quality measurements in the main vent.

For the accuracy, each measurement has been conducted three times for each point. Furthermore, the average values for each parameter gained from these measurements were compared to the 'Interim National Water Quality Standard (INWQS) for Malaysia' and then referred to 'Water Classes and Uses' (DOE Malaysia 2011; Appendix A).

The results of the average of these in-situ measurements were summarised in Table 2 (for the measurements in January 2014 or in the dry season) and Table 3 (for the measurements in August 2014 or in the rainy season). Based on the measured parameters in both dry and rainy seasons, some parameters are significant to determine the water classes and uses, they are pH, temperature, and DO. Meanwhile, other parameters such as TDS, salinity, and conductivity give insignificant readings.

According to the measurements in the dry season and compared to INWQS for Malaysia, the hot water in the main vent (pH: 9.12; temperature: 72.31°C; DO: 0.08 mg/l) is considered as "Class V" which means that the water in this point could not be used for water supply for human uses (such as for drinking and taking a bath). Direct body contact with the water should be prevented because of its very high temperature. However, this water is possible to be used to boil eggs. An experiment to boil some eggs in this point was conducted for 30 minutes and has successfully produced only half cooked eggs (not fully cooked eggs). Meanwhile, the flowing water area (pH: 9.01; temperature: 66.06°C; DO: 1.95 mg/l) and the collecting pond (pond 2 now, pH: 8.96; temperature: 56.34°C; DO: 2.64 mg/l) are in the category of "Class IV" which means that the water in these points also

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could not be used for water supply for human uses, but it can be used for irrigation.

For the measurements in the rainy season, the main vent (pH: 9.21; temperature: 71.33°C; DO: 0.39 mg/l) and the secondary vent (pH: 9.09; temperature: 70.16°C; DO: 0.17 mg/l) are considered as "Class V". The flowing water area (pH: 8.96; temperature: 60.49°C; DO: 3.7 mg/l) is in the category of "Class III" which means that the water in this point can be used for water supply with the extensive treatment requirement. In addition, this water can also be used for tolerant species of fish and livestock drinking. Pond 1 (pH: 9.06; temperature: 60.16°C; DO: 2.41 mg/l) is in "Class IV", meanwhile other ponds: pond 2 (pH: 8.86; temperature: 41.19°C; DO: 5.18 mg/l), pond 3 (pH: 8.72; temperature: 38.60°C; DO: 5.89 mg/l), and pond 4 (pH: 8.64; temperature: 32.23°C; DO: 6.17 mg/l), and the discharge point near the river (pH: 8.16; temperature: 33.69°C; DO: 6.77 mg/l) are considered as "Class IIB" which mean that the water is suitable for recreational uses where the body contact with the water is allowed.

Table 2: In-situ water quality measurements at some points in the hot spring area during the dry season (23 January 2014; 10:00 AM)

Measurement Point	GPS Coordinates	pH	Temp. (°C)	TDS (mg/l)	Salinity (ppt)	Conductivity (µS/cm)	DO (% saturation)	(mg/l)	Class
The main vent	04° 42' 35.19" N, 101° 34' 3.9" E	9.12	72.31	0.193	0.13	0.566	2.1	0.08	V
The flowing water area	04° 42' 35.06" N, 101° 34' 4.46" E	9.01	66.06	0.122	0.08	0.326	42.05	1.95	IV
The collecting pond	04° 42' 35.16" N, 101° 34' 5.19" E	8.96	56.34	0.185	0.12	0.458	42.43	2.64	IV

Table 3: In-situ water quality measurements at some points in the hot spring area during the rainy season (31 August 2014; 10:00 PM)

Measurement Point	GPS Coordinates	pH	Temp. (°C)	TDS (mg/l)	Salinity (ppt)	Conductivity (µS/cm)	DO (% saturation)	(mg/l)	Class
The main vent	04° 42' 35.19" N, 101° 34' 3.9" E	9.21	71.33	0.180	0.12	0.522	9.8	0.39	V
The secondary vent	04° 42' 35.73" N, 101° 34' 4.52" E	9.09	70.16	0.165	0.11	0.473	4.23	0.17	V
The flowing water area	04° 42' 35.06" N, 101° 34' 4.46" E	8.96	60.49	0.175	0.12	0.452	79.2	3.7	III
Pond 1	04° 42' 34.82" N, 101° 34' 4.82" E	9.06	60.16	0.179	0.12	0.459	51.27	2.41	IV
Pond 2	04° 42' 35.16" N, 101° 34' 5.19" E	8.86	41.19	0.177	0.12	0.356	82.37	5.18	II B
Pond 3	04° 42' 35.61" N, 101° 34' 5.93" E	8.72	38.60	0.169	0.12	0.327	89.93	5.89	II B
Pond 4	04° 42' 35.43" N, 101° 34' 6.04" E	8.64	32.23	0.182	0.13	0.319	84.76	6.17	II B
The discharge point (near the river)	04° 42' 34.17" N, 101° 34' 10.91" E	8.16	33.69	0.159	0.11	0.286	96.23	6.77	II B

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In general, the in-situ water quality measurements in both dry and rainy seasons in all measurement points in this site show that the pH of the water is more than 8, which indicates that the hot spring is natural alkaline spring. The main vent has the highest pH of water during both the dry season (pH 9.12) and the rainy season (pH 9.21). For the temperature of the hot water, the main vent has the highest temperature of water during both the dry season (72.31°C) and the rainy season (71.33°C). The values of pH and temperature decrease and the values of DO increase where the water flows more distant from the source points (the vents). Other parameters show irregular patterns of values and do not affected by the distance of the points from the vents. The supply of rain water mainly during the rainy season will effect only to the decreasing of temperature and the increasing of DO.

3.5. Geotourism Potentials

This site should be conserved and developed since it possesses some geoheritage values which in the same time also becomes a tourism attraction. Many people, mainly locals and aboriginal people as well as plantation workers in Lojing Highlands, and some other people who pass through the Gua Musang – Cameron Highlands Highway, are interested in visiting this hot spring. Based on the site observation, most people come to the site along with their friends or relatives in groups (Fig. 9a). The number of visitors increases in the public holidays.

Figure 9: The Pos Hendrop hot spring should be conserved and developed to become a geotourism site in Lojing Highlands, Kelantan. (a) A group of people visit the hot spring site; (b) Eggs boiling is a favourite activity in the site.

The in-situ measurements of its water quality parameters in the recent time, mainly the temperature, show that among the possible activity can be conducted in this site is egg boiling activity. Visitors who bring along some eggs to the site can boil their eggs in the main vent and the secondary vent which have temperatures of more than 70°C (Fig. 9b). Meanwhile, pond 2, pond 3, and pond 4 are suitable places for bathing and heating as well as the hot spring therapy and the skin treatment (with temperatures are tolerant for human body contact i.e. 32.23°C – 41.19°C). The flowing water area and pond 1 are less suitable for human body contact since the water still has high temperature (more than 60°C). Since it is situated near the highland forest, some other activities can also be conducted around the area such as jungle trekking and hiking. Other than conservation and development efforts, improvement on cleanliness and some water treatments should also be implemented to the site so that this area can be gazetted as a geotourism site in Lojing Highlands.

The site should also be provided with a space, facilities, and infrastructures to be able to organize tourism and recreational programmes and activities. It is potential to provide benefits to the local community, the state, and even the country. In addition, planning and management of this geosites should be prepared for its development. Based on an interview with the authority, they are planning to develop this area as a tourism site by utilizing the hot spring. They are also planning to build some facilities and infrastructures including a hotel or homestay equipped with hot water

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pools so that visitors can enjoy hot water bathing and heating and some other activities in the site. The hot water should be treated properly such as by mixing it with the normal water so that the temperature of the hot water will be reduced and become the warm water, so it will make it possible for visitors to contact with the water.

4. Conclusions

The Pos Hendrop hot spring, which is situated in a relatively plain area and surrounded by the hilly area in Lojing Highlands of the southern Kelantan, and is geologically composed of the Main Range Granite, possesses geoheritage values such as scientific, aesthetic, recreational, functional, and economic values. In-situ water quality measurements which were conducted in both dry and rainy seasons show that this hot spring area generally has the water classes range from "Class IIB" to "Class V" (according to INWQS for Malaysia). This geosite is potential for geotourism purpose since it can attract geoscientists (or geologists), to study on this hot spring, and general public to visit the area and enjoy some specific programmes and activities such as egg boiling, bathing and heating, hot spring therapy, skin treatment, as well as jungle trekking and hiking. This hot spring should be conserved and developed properly so that all these activities and more other tourism activities can be conducted there. The water of the hot spring needs the proper treatments before it will be used for human uses and tourism purposes. This study also recommends that this area should be supported as a potential geoheritage resource and a sustainable geotourism site in Lojing Highlands.

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The authors would like to thank Faculty of Agro-based Industry and Faculty of Earth Sciences, Universiti Malaysia Kelantan (UMK) Jeli Campus for organizing a scientific expedition in January 2014 to explore some parts of Lojing Highlands including the Pos Hendrop hot spring area. This expedition and a subsequent field work (in August 2014) have managed to investigate the geological condition, geoheritage and geotourism potentials, and the water quality of the hot spring. The authors would also like to appreciate the local community of Temiar for guiding us during the expedition. Thanks are also due to all colleagues and researchers involved in the expedition and the field work.

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Appendix A

Interim National Water Quality Standard (INWQS) for Malaysia (DOE Malaysia, 2011)

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammonical Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 - 7	3 – 5	< 3	< 1
pH	-	6.5 – 8.5	6 - 9	6 - 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	µS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	^{0}C	-	Normal + 2 ^{0}C	-	Normal + 2 ^{0}C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	Count/100 ml	10	100	400	5000 (20000)[a]	5000 (20000)[a]	-
Total Coliform	Count/100 ml	100	5000	5000	50000	50000	> 50000

Note:
N : No visible floatable materials or debris, no objectional odour or no objectional taste
* : Related parameters, only one recommended for use
** : Geometric mean
a : Maximum not to be exceeded

Water Classes and Uses (DOE Malaysia, 2011)

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above

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