PRELIMINARY GEOTOURISM STUDY IN ANCIENT KHMER CIVILIZATION AREA, BURIRAM PROVINCE, NORTHEASTERN THAILAND

Vimoltip Singtuen

KritWon-In*
Department of Earth Science. Address: 50 Phahon Yothin Rd. Chatuchak. Bangkok. 10900 POBox 1020. Thailand, kritwonin@yahoo.com

ABSTRACT
Buriram is a province in lower Northeastern Thailand, and its terrain is at the Khorat plateau, which is created by volcanic activities. Based on the field observation, inventory, and characterization, this area comprises four volcanoes and two Khmer sandstone geoheritage sites. These volcanoes are covered by basaltic rock and volcanic bomb, which created the volcanic shield morphology. The most famous sandstone geoheritage is Prasat Hin Phanom Rung, which has also been submitted for evaluation as a UNESCO world heritage site. Sandstone and laterite created both Prasat Hin Phanom Rung and Prasat Mueang Tam under the influence of the Khmer Culture. This sandstone is classified into subarkose and is grouped in Phra Wihan Formation of the Khorat Group based on the composition. The aims of this study are making tourists better understanding of the geologic processes and geoconservation. Moreover, this study is a powerful tool for sustainable development and can promote the geologic and volcanic monuments, so, this area needs greater conservation.

Keywords: Geotourism, Volcanic Geoheritage, Sandstone Castle, Ancient Khmer Civilization, Northeastern Thailand

Introduction
Geotourism is going to become an essential touristic activity all around the world, which focuses on the geology in both local and national level during two decades (Dowling, 2011; Dowling & Newsome, 2010; Farsani et al., 2014; Gray, 2013; Lazzari & Aloia, 2014). Recently, many countries have introduced programs to identify and describe their critical geoheritage sites such as Northeastern Africa, Western Asia, and Southeast Asia especially Thailand (AbdelMaksoud et. al., 2018; Habibi & Ruban, 2017, 2018; Habibi et. al., 2017; Sallam et. al., 2017, 2018a, 2018b; Singtuen & Won-In, 2017, 2018).

Thailand has many shield volcanoes, have been erupted in thousands of years ago, but now these volcanoes are extinct (Carbonel et al., 1972; Barr et al., 1976; Fontaine and Workman, 1978). Nowadays, they look like general mountains exclude volcanoes in Lampang and Buriram, where have perfectly morphology of volcanoes. Buriram is located in northeastern Thailand and is at the southern end of between Thailand and Cambodia, which is located at the Sankamphaeng Range and the Dângrêk Mountains. Based on many pieces of evidence such as traces of human habitation and ancient pottery suggest that Buriram was a center of the Khmer civilization in 15th to the 18th Buddhist centuries (Walter, 1999). It is also a city rich in local wisdom and culture. Buriram also has a rich, interesting Khmer Civilization area such as historical heritage, cultural and natural sites (Freeman, 1996, 1998). The stone sanctuary is the one of the historical heritage, which remains as architectural masterpieces, which attract both Thai and Foreign tourists (Denes, 2010).

This research is the first stage to encourage geotourism in volcanic and sandstone heritage sites in Thailand for promoting to international level. Furthermore, it shows that the Ancient castles and died volcanos, a world-renowned historical and artistic monument, is also a monument of geology and volcanology, accordingly, these geosites need greater conservation in term of geoconservation for the next generation.

Materials and Methodology
This research has many materials, which are the topographic map, geologic map, photographs, field gears (magnifying loupe and geologic hammer), and literature related to the topic and the study area. Meanwhile, the methodology comprises a literature review, a travel map creating, field observation, inventory, characterization, geotourism planning and SWOT analysis. The inventory consists of identification and mapping of selected geosites. The characterization of geosites is carried out by observing and describing the landform and rock occurrence in detail. The geotourism planning is the method to interpret and manage the geosites in the study area for the effective travel industry. The SWOT analysis is used to evaluate the geosite and is necessary data to plan the strategy for geotourism development.

**General Geology**

The studied areas are small hills (height 200-300 meters) of the basaltic rocks such as Khao Kradong, Khao Phanom Rung, Khao Angkhan, and Prasat Mueang Tam area. It also flows above on the Khorat sedimentary rocks. The Khorat sedimentary rocks in this area comprise Jurassic to Tertiary ages include Phra Wihan, Sao Khau, Phu Pha, Khok Kruat, and Maha Sarakham Formations. They mainly consist of sandstone and siltstone, with a small amount of conglomerate (Fig. 1). The basaltic eruption comprises two episodes which are 1) the Khorat Plateau uplift beginning stage and 2) the Khorat Plateau uplift finish stage (Jungyusuk and Sirinavin, 1983). These basaltic rocks have age between 0.6–0.7 million years ago which is the Early Quaternary period (Carbonel et al., 1972; Barr et al., 1976; Fontaine and Workman, 1978).

**Geotourism**

This research creates the travel route (Fig. 2). It allows the tourist to experience the significance of the volcanos and learn the origin of rocks. The Tourists also trek along natural trails on top of these volcanos (Fig. 3). Then observe the grateful of sanctuary including Prasat Hin Phanom Rung and Prasat Mueang Tam. Next, admire the conservation of community forests and local wisdom in the production of Phu Akkhani, the Fire Mountain textile.

![Fig 1: Geologic map of the selected study case in Buriram Province, Thailand (modified from the Department of Mineral Resources, Thailand, 2007)](image1)

![Fig 2: a) Travel route of the basaltic geosite resources and historical sites in Buriram Province and b) Google Earth image of Buriram Province, showing the location and morphology of volcanoes at Ban Charoen Suk. All these geotourism offered on the route tell stories about the origins of the volcanoes, expansion of the ancient Khmer Empire, the emergence of communities and significant historical sites, and efficient utilization of natural resources for sustainability. Although the geosites are far from the Buriram city center, there is excellent accessibility for the travelers. In addition, to emphasize its richness in cultural heritage, there are crafts like silk and Na Pho Mudmee (woven materials). Currently, Buriram has a famous football stadium and international motorsport race track, where many tourists already visit.](image2)
Volcanic Feature

There are four outstanding shield died volcanoes in Buriram Province (Fig. 2b), which are Khao Kradong (14.9406°N 103.0930°E), Khoa Phanom Rung (14.5528°N 102.9495°E), Khao Akkhani (14.5353°N 102.8343°E), and Khoa Bud Plai (14.4812°N 102.9681°E). They usually built almost entirely of fluid lava flows and showed their low profile, which is similar to shield lye on the ground (Fig. 3a). The morphology of shield volcanoes is due to the low viscosity of their mafic lava, and this results in the steady accumulation of sheets of lava, building up the shield volcanoes distinctive form. The crater of the volcanoes is full of water, which is accumulated during the rainy season (June-September) in Thailand, so the tourist finds are difficult to find the crater (Fig. 3b). The mafic volcanic feature comprises basaltic rocks (Fig. 3c), basaltic flow, and volcanic bomb (Fig. 3d). They show very fine-grained extrusive texture and have black color in the surface. In Phu Akkhani volcano; the investor creates the basalt quarry for the construction in Northeastern Thailand (Fig. 3e). In this case, it has a risk of being destroyed by man-destruction more than another factor.

Sandstone Geoheritage

The famous sandstone geoheritage of Buriram Province are the ancient Khmer castles including Prasat Hin Phanom Rung (Fig. 4a) and Prasat Mueang Tam (Fig. 4b). Both sandstone and laterite are selected for creating these Ancient Khmer castles (Fig. 5). The field observation suggests that the Prasat Hin Phanom Rung and Prasat Mueang Tam have a similar pattern of construction and geologic materials selection. The sandstone blocks are selected to create the door, window, roof, internal wall and decorative engraving. Meanwhile, the laterites are selected to build the base of the castle and external wall.

Fig.3: The volcanic feature of Buriram Province; a) the volcanic morphology, the crater of Khao Kradong volcano, c) basaltic lava flow, d) volcanic bomb, and e) basaltic rocks quarry
Prasat Hin Phanom Rung is located on an extinct Phanom Rung volcano, while Prasat Mueang Tam is located near Khoab Bud Plai volcano. They are a Hindu shrine, built in dedication to Shiva, and symbolizes Mount Kailash, his heavenly dwelling (Chandler, 2000; Mabbett & Chandler, 1995; Nidhi, 1976). These days they are open to the public, in the Phanom Rung historical park. Prasat Hin Phanom Rung has also been submitted for evaluation as a UNESCO world heritage site.

Based on the research of department of Fine Art Thailand (1996), these sandstone geoheritages are constructed from sandstone quarried from Ban Kruat District, which is located on the southern flank of this province on 14.3648°N 103.0852°E (Fig. 6). The sandstone is a part of the Phra Wihan Formation of the Khorat Group and shows white-pink color, medium-grained size, subangular to sub-round in shape, medium sorting, and ferrogenous cement (Fig. 7). There are many quartz gravels, which are approximately 2-6 millimeters across and show cross-bedding in the sedimentary structure part. Its sand grains consist mainly of 80 % quartz, subordinated with 15% feldspar and 5 % rock fragments and with a small amount of mica and opaque mineral. It is classified to subarkose based on sandstone classification of Pettijohn (1975).
In the case of laterite, no one has data of the origin, but this material is taken from Prachin Buri Province in the southern part of the study area for restoration in recent. The laterites in the study area show light-brown color and have many pores. They contain fine-grained sediments and no large-sized gravels.

**Provision for Tourism**

The Phanom Rung historical park is an international historical attraction, advertised as a famous site and comfortable access. Other sites also easy to reach by graded field road and have good management by local and national government. However, there is not the interpretation of landform diversity and origin of rocks in the study area. Due to its large size and the development of the national park, the outdoor recreation ground is frequently visited. There are many facilities such as a small hall, viewing point, and accommodation including tent and room. The tourist information center and map always provide the data and location of the sites in the park. The park can be visited through year-round, but the phenomena of sunray through15 doors in the Phanom Rung historical park occur four times each a year. The tourists can see the sunrise pass through 15 doors on 3-5 April and 8-10 September. From 5-7 March and 6-8 October, they also can see the sunset. The tourist can see the morphology and perfect shape of the shield volcanoes when driving on the road. In addition, these geosites and historical sites are managed to mix with the natural sites. Local people manage the external accommodation and restaurants present in many places near these studied sites.

**SWOT Analysis**

The SWOT analysis is used to evaluate the geosite in this research. In addition, it is a useful tool for management planning, which takes into consideration many factors. The SWOT analysis is the methodology, which focuses on the strength, weakness, opportunity, and threat of the selected study area. Table 1 lists the SWOT analysis of the geosite for conservation and development. The data from this method can make the geosite stand out in the strength and opportunity. Whereas, it can also control and decrease the factor of the weakness and threat. Consequently, Buriram has high potential in both geological and historical sites for research and public education. Moreover, it has a high aesthetic and cultural value, which makes the area more attractive. If the government can protect the threat and promote this geosite, Buriram will establish itself and be of great benefit to Thailand. We also apply this data to sustainable development and management to conserve the geosite for the future generations. The government should support the financial for practicing the local people cooperating with the local authority in term of the geoscientific knowledge, guide training, local business management (accommodation and restaurant), and souvenir shop development. Moreover, the local authority should solve two issues that are Lack of promotion of the area and Lack of the public transportation. Public transportation needs to increase the number of bus, van, or car for facilitating tourists to reach the attractions and geosites. They should also improve the advertisement chance to promote the area such as social media, advertising panels in Buriram city center and billboards on the public transportation. This research will motivate Thai and foreign geologists, volcanologists, geoheritage researchers, and geotourists traveling to northeastern Thailand to include Buriram city in their itinerary.

**Table 1:** SWOT analysis to evaluate the study area for conservation and development

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<td>- Good management and protection from National Park</td>
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<td>- A high aesthetic value such as viewscape, nature, and Khmer civilization</td>
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<tr>
<td>- Many information panels to serve visitors</td>
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<td>- High cultural value of aboriginal people</td>
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<td>- Some sites have historical and economic values</td>
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<td>- Good accessibility</td>
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Conclusion

The study area is a land of volcanoes and ancient Khmer civilization sites, which make it valuable as historical and geological attractions. The study area consists of four shield volcanoes, which are Khao Kradong, Khao Phanom Rung, Khao Akkhani, and Khao Bud Plai. The volcanic feature in this area comprises basaltic rocks, basaltic flow, and volcanic bomb. There are two Ancient Khmer castles including Prasat Hin Phanom Rung and Prasat Mueang Tam. The subarkosic sandstone and laterite are selected to create in both castles. The subarkosic sandstone is a part of the stratigraphy of Phra Wihan Formation, Khorat Group and took from the Ban Kruat District, the southern flank of Buriram Province. The travel route is created for geotourism promoting and sustainable developments in Buriram Province. In addition, this research will help tourists understand the geological processes and realize the important of the geomorphological heritage conservation.

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