

# ARCHAEOLOGICAL DISTRIBUTION OF GEOHERITAGE FOR GEOTOURISM DEVELOPMENT IN NAKHON SAWAN PROVINCE, THAILAND

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**ABSTRACT:** Nakhon Sawan Province is located in Upper Central Thailand, where the Chao Phraya River, the vital river of Thailand, begins. According to the distribution of the archaeological sites, the related geological features were divided into two groups by geodiversity scope: (1) hydrological sites - Chao Phraya river, Bueng Boraphet lake, (2) speleological sites - Tham Phet-Tham Thong cave and Khoa Nor mountain. The hydrological sites are the primary water resources of local people since many hundred years, including transportation, agriculture, and fishery, so there are many archaeological sites around there. In addition, the speleological sites are covered with limestones intruded by the granitic rocks, which has caused ore deposition in the form of skarn. The evidence of antiquities in the archaeological site near speleological sites suggests that ancient people discovered and produced their ores, notably iron in the studied area. Based on inventory, characterization, classification, and assessment methods, this preliminary geoarchaeology study can support Nakhon Sawan to promote geotourism for sustainability by their stunning geological features, fantastic nature as well as beautiful culture, both past and present.

**KEY WORDS:** geosite, geoarchaeology, geodiversity, geoheritage, SWOT analysis

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## Introduction

Archaeology is knowledge application of both social science and humanities, which study the ancient-human activities by recovery and analysis of material culture (Little 2006, Sinclair 2016). Archaeological distribution is the pattern of the location of archaeological sites of material culture over regions that get data from field surveys, generalizations, and hypotheses testing (Banning 2002).

Nakhon Sawan Province, Central Thailand has many archaeological sites from the 6<sup>th</sup> to

11<sup>th</sup> centuries C.E. distributed along the main river and also the nearby limestone mountain (Murphy, Pongkasetkan 2010). This point is the question that this research attempts to answer, that is, what is the relationship between ancient people's settlement and important geological features. So, this work explores the relationship between archaeology and geology based on the authors' own experience. Geological features are the characteristics of morphology or material, which have occurred through geological processes such as a river, cave, mountain, gorge, glacier, volcano, coastal regions, hot

spring, and other resources. All of these features are called geodiversity that are directly related to space and have a location as well as related to the time component (Gray 2004, Zwoliński 2004). Geological features of archaeological sites may be of heritage value (Moroni et al. 2015). This scheme always has an impact on human life, especially livelihood, occupation, resources, and economy. The goal of this research is to describe the relationship between the archaeological site and geological features for inventoring geoheritage resources. Geoheritage, due to its uniqueness with many values in term of geology, nature, culture, and tourism, can

promote this area to the geotourism industry by geology and landscape (Hose 1995, 2000, Gray 2004, 2005, 2008, 2011, Thomas 2006, Newsome, Dowling 2010). There are many works to study a point of geotourism in the outstanding geosites of Thailand for developing the knowledge and concept about this scheme (Singtuen, Won-In 2017, 2018a, 2018b, 2018c, Nazaruddin 2019, Singtuen et al. 2019, 2020). Regarding the 12<sup>th</sup> National Economic and Social Development Plan (2017–2021) of Thailand, geotourism can increase the point of economic, scientific, and social advancements towards sustainable development goals.

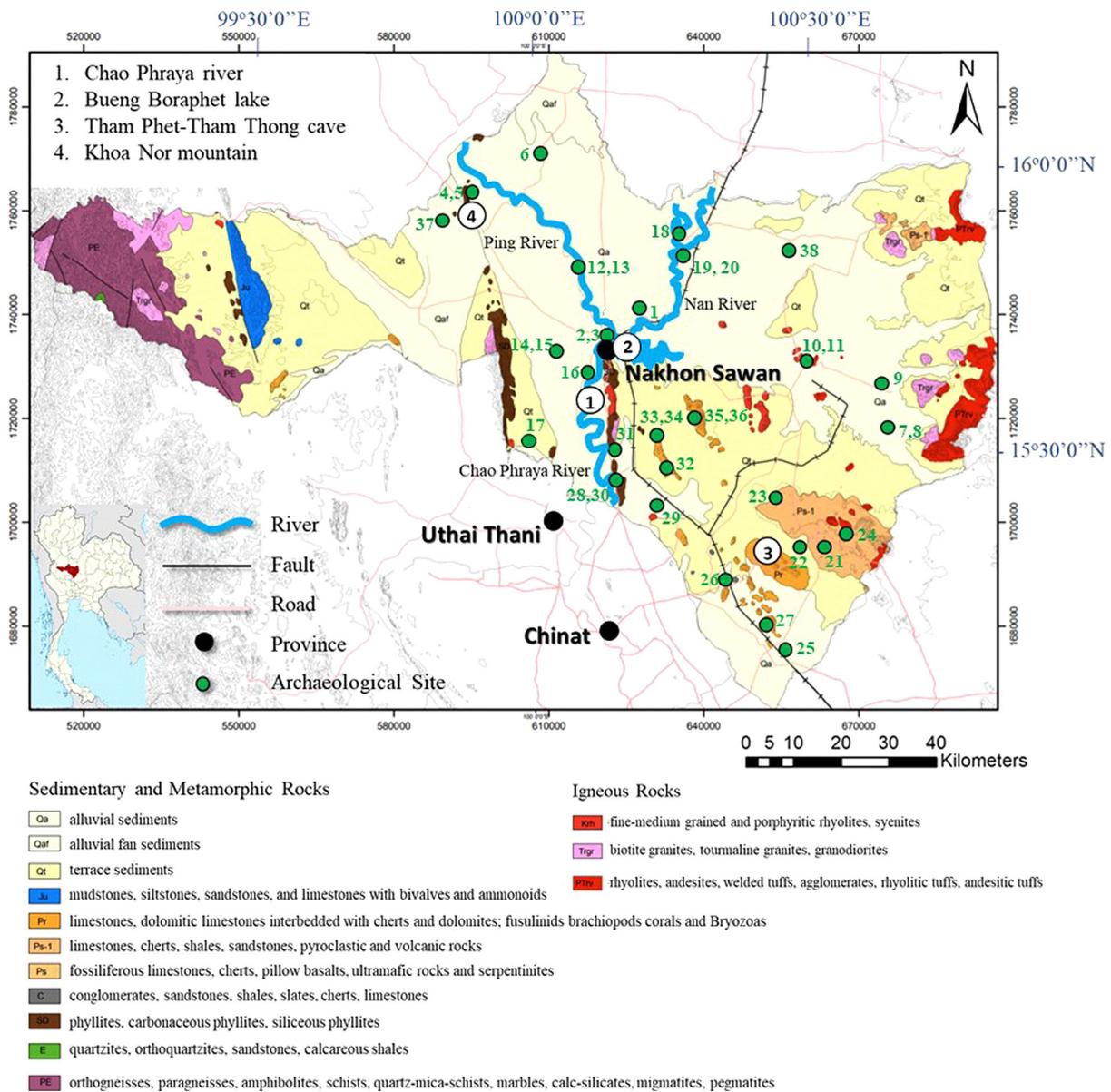


Fig. 1. Archaeological sites distribution in the geologic map of Nakhon Sawan Province. Satellite data taken from ArcGIS® and geologic data modified from DMR (2007a).

## Geology of the study area

Nakhon Sawan Province is located in the central plain of Thailand. This area shows elevated relief, which consists of sparsely single mountains located in the floodplain of Chao Phraya River, which runs through a pass in N-S direction. The single mountains are dome, hemisphere, block, and long ridge in shape. They stand vertical in an almost flat plane in this area and are classically identified as monadnocks, however, the structural control ridges are presented in the modern geological reports (Morley et al. 2007, Prasongtham, Kanjanapayont 2014). Chao Phraya River and its watershed area is the greatest river system in central Thailand, with a large number of the Quaternary sediments (alluvial sediments [Qa], alluvial fan [Qaf] and terrace sediments [Qt]) and Bueng Borapet lake in this area (Fig. 1). Under the Quaternary cover, this area is built of igneous rocks, sedimentary rocks, and metamorphic rocks that have been around since the Precambrian. The Precambrian (PC) and Cambrian (C) rocks are distributed in the western part of the area as high mountain landforms composed of high-grade metamorphic rocks (gneisses, schists, and calc-silicate rocks) and quartzites, respectively (Fig. 1). The geological age of single mountains in Nakhon Sawan Province can be divided into seven periods:

1. Silurian-Devonian (S.D.) low-grade metamorphic rocks (marbles, slates, phyllites, quartzites, meta tuffs) and cherts, such as Khao Nor marble,
2. Carboniferous (C) sedimentary rocks (conglomerates, sandstones, shales, limestone, and cherts), such as small hills in Thakli District,
3. Permian (Ps, Ps-1, Pr) limestone, such as Tham Phet – Tham Thong limestone,
4. Permo-Triassic (PTrv) volcanic rocks (andesites, rhyolites, and associated tuffs), such as Khao Soi Dao,
5. Triassic (Trgr) granites (hornblende granites and syenites), a part of Eastern Belt Granite of Thailand has been formed as arc subduction of Palaeo-Tethys beneath Indochina Terrane (Fanka, Nakapadungrat 2018),
6. Jurassic (Ju) sedimentary rocks (mudstones, siltstones, and sandstones), such as Khao Chon Kan,

7. Cretaceous (Krh) acid volcanic rocks (rhyolite and rhyolite porphyry), such as Khao Panom Chat.

Accordingly, magmatic activity in this area – both extrusive and intrusive, for example, Permian limestone intruded by Triassic granites – left many ore deposits affected active mines and post-mining areas presently exposed as historical sites in Takhli and Tak Fa districts (Jungyusuk, Khositanon 1992, DMR 2007). A unique distribution of a single mountain morphology and variation of geology (geodiversity), including rock types and periods of formation, makes this area unique in terms of geotourism.

## Methodology

The methodology of this research consists of inventory, geological field investigation, characterization, classification, assessment, and discussion. This research was carried out during the first half of 2018. The prime method was making an inventory of the archaeological sites in Nakhon Sawan Province by literature review. The archaeological sites are distributed in thirteen districts (Table 1): Mueang Nakhon Sawan, Krok Phra, Chum Saeng, Nong Bua, Banphot Phisai, Kao Liao, Takhli, Tha Tako, Phaisali, Phayuha Khiri, Lat Yao, and Tak Fa districts, excluding the western part such as Mae Wong, Mae Poen, and Chum Ta Bong districts (Fig. 1). After that, authors inventoried the geosites by field survey for characterization in geologic knowledge and tourism information (Đurović, Đurović 2010). Four geosites near the archaeological sites were selected to classify in terms of geodiversity, rock, and occurrence. The geosites have an individual identity, are well-known, and also suitable for tourism and learning. Site characterization was carried out by observations and descriptions of geoscientific knowledge and tourism information for classification in terms of geodiversity, scope, rock, and occurrence (Gray 2005, Brocx, Semeniuk 2007, Đurović, Đurović 2010, Nazaruddin 2019, 2020). Both quantitative and qualitative assessments were conducted basis the evaluation of experiences of the authors and tourists to discuss the potential of geotourism in the area. Also, SWOT analysis was taken as the strategic planning technique for geoheritage

and geotourism development by focusing on strengths, weaknesses, opportunities, and threats of each area.

### Geoheritage in archaeological sites

The archeological sites in Nakhon Sawan present the Dvaravati culture (6th–11th century C.E.), similar to other archeological sites in central Thailand (Murphy, Pongkasetkan 2010). Dvaravati, the ancient kingdom of Southeast Asia, was first established in Thailand. There are shreds of evidence that indicate the critical political, economic, religious, and artistic center in the Upper Chao Phraya Basin played an important role as a propagator of Indian culture (Murphy, Pongkasetkan 2010, Rispoli et al. 2013). There are many highlights of archaeological sites in Nakhon Sawan such as Muaeng Bon stupa (Fig. 2a), ancient Buddha's image in Khok Mai Den (Fig. 2b), Khok Mai Den ancient city wall (Fig. 2c), Chan Sen Museum (Fig. 2d), and SEMA (evidence of ancient temple) by volcanic rocks (Fig. 2e). The archeologists suggest that this area had metallurgical activities in the early Iron Age and also had fields for agriculture (Rispoli et al. 2013, Higham et al. 2011). For example, near Tham Phet-Tham Thong cave, metallurgical activities (Fig. 3a) are presented by evidence as an exhibition in their museum or temple near the excavation sites. Museums listed in Table 1 exhibit cultural objects of ancient Thais and some evidence related to geology or geological materials of the area such as mining, the stratigraphy of ancient ponds, mortars (rock) pestles for pharmacy, potteries, and clay artifacts (Fig. 3b–c).

Geoheritage in archaeological sites were inventoried as four areas, which comprise Chao Phraya river, Bueng Boraphet lake, Tham Phet-Tham Thong cave, and Khoa Nor mountain. All of these are spectacular geomorphological sites

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Fig. 2. Archaeological sites in Nakhon Sawan.

a - Muaeng Bon Stupa, b - Ancient Buddha's Image in Khok Mai Den, c - Khok Mai Den archaeological site, d - Chan Sen Museum, e - SEMA (evidence of ancient temple) by volcanic rocks.



Fig. 3. Archaeological evidence in Nakhon Sawan.

a - ancient knives and smelted steel artefacts, b - rock mortars-pestles for pharmacy, c - potteries and artefacts by clays.

Table 1. Location of Archaeological Sites in Nakhon Sawan Province, Thailand.

No.	Icon	Archaeological Site	Sub-district	District	Location
1		Kiang Krai Temple	Kiang Krai	Mueang Nakhon Sawan	15°44'24"N, 100°11'24"E
2		Chom Khiri Nakprot Temple	Nakhon Sawan Ok		15°40'48"N, 100°07'48"E
3		Khao Kop Temple	Pak Nam Po		15°42'36"N, 100°08'24"E
4		Pra Non Cave	Ban Dan	Banphot Phisai	15°57'00"N, 99°52'48"E
5		Khao No Temple			15°57'00"N, 99°52'48"E
6		Dong Mae Nang Mueang	Charoen Phon		16°01'12"N, 100°00'36"E
7		Khok Phraya Pao Kao	Samrongchai	Phaisali	15°30'36"N, 100°40'12"E
8		Mueng Apaisawi (Muengapaisali)			15°31'12"N, 100°39'00"E
9		Luang Pho Dam Temple	Khok Duea		15°36'00"N, 100°38'24"E
10		Ban Khao Lo Archaeological Site	Don kha	Tha Ta Ko	15°39'36"N, 100°29'24"E
11		Khok Prasath			15°38'24"N, 100°30'00"E
12		Khao Din South Temple	Khao Din	Kao Liao	15°49'12"N, 100°04'48"E
13		Maha Phot South Temple	Maha Phot		15°49'12"N, 100°04'48"E
14		Tha Sud Temple	Bang Prabang	Krok Phra	15°39'36"N, 100°02'24"E
15		Bang Prabang Temple			15°37'12"N, 100°02'24"E
16		Bang Mafo Temple	Bang Mafo		15°36'00"N, 100°06'00"E
17		Nong To Temple	Hat sung		15°30'36"N, 99°58'48"E
18		Koei Chai North Temple	Koei Chai	Chum Saeng	15°52'12"N, 100°16'12"E
19		Nong Pha Krot Nok Temple	Phan lan		15°48'00"N, 100°15'36"E
20		Tham Noen Phraprang Temple			15°49'48"N, 100°15'36"E

No.		Archaeological Site	Sub-district	District	Location
21		Tham Pra	Tak Fa	Tak Fa	15°17'24"N, 100°32'24"E
22		Ban Phu Nimit			15°18'00"N, 100°30'00"E
23		Ban Phu Men Archaeological Site	Phu Nok Yung		15°23'24"N, 100°27'00"E
24		Tham Pon Sawan Temple	Lam Phayon		15°19'12"N, 100°34'48"E
25		Ban Khok Chan Sen Museum	Chan Sen	Takhli	15°07'02"N, 100°27'07"E
26		Ban Ta Khli	Ta Khli		15°14'24"N, 100°21'00"E
27		Ban Bo Din Khao	Phrom Nimit		15°09'36"N, 100°25'48"E
28		Muenag Bon (Ban Nong Mai Den)	Tha Nam Oi	Phayuha Khiri	15°25'12"N, 100°09'00"E
29		Khok Mai Den Ancient Group			15°24'36"N, 100°09'00"E
30		Phrapang Lueang Temple			15°25'12"N, 100°08'24"E
31		Khao Kaew Temple	Phayuha		15°27'36"N, 100°08'24"E
32		Ban Khao Bo Pub	Muang Hak		15°22'48"N, 100°13'12"E
33		Sa Thale Temple	Sa Thale		15°29'24"N, 100°09'00"E
34		Khok Sam Rit Archaeological Site	Khao Thong		15°32'24"N, 100°10'12"E
35		Ban Khu Muang Museum	Nikhom Khao Bo Kaeo		15°26'24"N, 100°16'12"E
36		Khao Sa Nang Song			15°27'36"N, 100°15'00"E
37		Ban Khlong Kradan	Ban Rai		Lad Yao
38		Huai Thua Tai Archaeological Site	Huai Thua Tai	Nong Bua	15°50'24"N, 100°28'12"E

Symbols:  - temple,  - evidence with natural site,  - archaeological site,  - museum.

supported and promoted in tourism activity, especially Kho Nor Mountain that is a favorite place of adventure tourists. Based on geodiversity, the studied area composed of rocks, minerals, fossils, landforms, landscapes, processes, and other resources (Gray 2005). Geoheritage were classified into two main groups by difference in identity scope as hydrological and speleological sites.

### Hydrogeological site

Two areas were divided into hydrological sites, which have the criteria of hydrology and water resources. The Chao Phraya River is one of the most magnificent rivers in Thailand and also

has *Pak Nam Pho* confluence in Nakhon Sawan (Fig. 4a). It is a meandering river, which presents many fluvial structures such as oxbow lakes, meander scars, swamps, floodplains, and natural levees. Many people know that there are four streams (*Ping*, *Wang*, *Yom*, and *Nan* rivers) that originate at the high mountains in the northern part of Thailand and flow to meet together in this area as a river confluence. On the other hand, *Ping* and *Wang* rivers merge at Tak province, and *Ping* (new river's name is same as the bigger stream) flows southward to join with *Nan* river, which has joined with *Yom* river in the northern part of Nakhon Sawan. So, this area consists of wonderful ABC resources that comprise abiotic components



Fig. 4. Geologic features in Nakhon Sawan.

a - the Chao Phraya River origin, b - Bueng Boraphet lake, c - rice field in a floodplain, d - Tham Phet-Tham Thong Cave, e - Khoa Nor Mountain, f - ancient temple evidence on the top of Khoa Nor.

(water, sand, and landforms), biotic components (plants and aquatic animals), and culture (art, the lifestyle of people, and history) along the river flowing through many districts. This area has the importance of local people over many years from past to recent times in terms of commerce, agriculture, and occupation presented by the archeological sites along Chao Phraya River. Many archeological sites with exhibitions present the ancient communities with local boats, old fish traps, and agriculture equipment along this river. It also has many activities and attractions to offer to tourists, such as cruises, floating restaurants, local market, viewpoint tower, and Chinese shrines. Local raw materials have been developed as souvenir items of the area, consisting of clay (pottery), rice (crisp rice) and fish (fish balls and Thai fish cakes).

Bueng Boraphet lake is the largest freshwater swamp in Thailand and home to many species of animals. The white-eyed river martin (Turner, Rose 1989) is believed to overwrite here but has not been recorded since 1980 and may now be extinct. Siamese tiger perch is the most important fish species, while the marsh grassbird was first seen here at the end of 2019. The area has research and training centers for the study of freshwater animals including an aquarium, museum, animal exhibitions as well as a tourism center. Boat trips are also available for tourists to enjoy the lake fauna and flora (Fig. 4b). Many souvenir shops sell local products related to the Chao Phraya River.

The cultural value of Bueng Boraphet is less than the Chao Phraya River but ancient railways and rice fields present the Thai cultural harvest and indigenous bird species (Fig. 4c).

### Speleological site

The national park sector protects Tham Phet-Tham Thong cave as a forest park, which conserves plants, wildlife, and physical features by Thai legislation. This forest park is located on Chon Deua hill, Takli District, with interesting scenery of forest and limestone mountain (more than 70 caves). However, the forest park opens only five big caves with stalagmites and stalactites in various shapes and colors as attractions (Fig. 4d). In addition, there are also the teenage local guides (10-15 years) and authorities to let tourists travel natural trail and visit limestone caves. Permian limestone in this area present many kinds of fossils, such as bivalves, crinoids, gastropods, and *Theosbaena kiatwongchai* n. sp. of *Thermosbaenacea* (Rogers, Sanoamuang 2016). Tham Phet-Tham Thong also has a potential of the stratigraphic site. At least twenty species of gastropods have been observed from Middle Permian, which was subdivided into three biozones: *Stegocoelia* sp., *Bellerophon* sp. - *Glabrocingulum* sp., *Stegocoelia* sp. zone, and *Bellerophon* sp. - *Glabrocingulum* sp. (Ketwetsuriya, Kanjanapayont 2016). The fossils suggest that limestone deposited in the shelf lagoon at the

back reef with low-energy environment and barren gastropod zone indicated a deep lagoon environment with a low-energy environment (Ketwetsuriya, Kanjanapayont 2016). This area is managed by the strategy of environmental education for participatory management (Panprom 2015). It also has archeological sites and museums nearby that show antique iron-smelting furnace, steel slag, ancient knives, and spears. Some places present evidence of post-mining areas around 20–30 years ago (DMR 2007).

Khoa Nor mountain is covered by Silurian-Devonian recrystallized limestone (Bunopas 1981) with a strike-slip fault structure (Morley et al. 2017), which makes this area a structural site. It is a dominant landform in this region that is standing on the central plain of Thailand. This place is very famous for adventure tourism; tourists hope to stand on the peak of the mountain at 314 m a.s.l. (Fig. 4e). Khoa Nor has the potential to promote scientific knowledge, especially geology to people. In addition, this area has a local guide to let tourists visit the nature trail, climbing area, and ancient temple (Fig. 4f) with hundreds of forest monkeys. Furthermore, there is a beautiful scenery of a number of bats flying out from the cave in the evening.

## Geotourism potentials

Nakhon Sawan has the potential for qualitative and quantitative assessments of geotourism development as geological features and

archeological sites (Table 2), together with other special tourism attractions. Here, interesting geosites that have historical significance are evaluated. Qualitative data were described, characterized and classified in the previous chapter. The geoarchaeological sites present the history of the area as four exhibitions consisting of the temple, evidence with original site (no information), archaeological sites (informative panels in an open-air site) and a museum with a curator.

This paper focuses on the development of the archaeological sites comprising outstanding geological features of rivers, mountains, caves and mineral resources to increase the historical value of the area. The Wat Phra Prang Luang archaeological site is located along the Chao Phraya River (Fig. 5). Many royal activities took place at the port in front of the temple hundreds of years ago. This area is supported by the local authorities who have created an exhibition to present local food, souvenirs and cultural shows to encourage people to wear traditional dress and join this annual festival.

The quantitative assessment focused on seven rubric criteria as follows:

1. Science and education: research and learning activities of the area at nursery, high school and university,
2. Culture: activities of the local people such as lifestyle, tradition, language, music, cloth and food,
3. History: the previous culture of the local people, presented by historical sites and archaeological evidence,

Table 2. Classification and Assessment of the Geoheritage in Nakhon Sawan, Thailand.

Area	Geodiversity <sup>a</sup>							Scope <sup>b</sup>	Value							
	Rock	Mineral	Fossil	Landform	Landscape	Process	Other Resources		Science & education	Culture	History	Nature	Aesthetically	Tourism	Economy	Total
Chao Phraya river	-	-	-	✓	✓	✓	S, W	Gm, Hd	5	5	5	5	5	5	5	35
Bueng Boraphet	-	-	-	✓	✓	✓	W	Gm, Hd	5	3	5	5	5	5	5	33
Tham Phet-Tham Thong cave	✓	✓	✓	✓	✓	✓	Fe	Gm, Sg, Sp	5	0	5	5	4	4	2	25
Khoa Nor mountain	✓	✓	-	✓	✓	-	-	Gm, St, Sp	5	2	5	5	5	5	5	32

<sup>a</sup> Gray 2005, <sup>b</sup> Brocx and Semeniuk 2007; Đurović and Đurović 2010.

0 - none, 1 - very bad, 2 - bad, 3 - fair, 4 - good, 5 - very good, S - sand, W - water, Fe - iron deposit (skarn), St - structural site, Gm - geomorphological site, Hd - hydrogeological site, Sg - stratigraphic site, Sp - speleological site.



Fig. 5. Wat Phra Prang Luang archaeological site.

4. Nature: biodiversity of both plants and animals as well as protection of national parks,
5. Aesthetics: scenery and recreational activities to attract and encourage visitors,
6. Tourism: accessibility, infrastructure, restaurants, hotels/resorts, souvenir shops, tourism information and local guides,
7. Economy: financial transactions between the local people and visitors to generate employment and promote a sustainable society.

An assessment was made using scores ranging from 0–5 points per criterion with 35 points as the

maximum. A zero score related to no value, while 5 attained the highest significance. The Chao Phraya River scored highest in the assessment, while Tham Phet-Tham Thong Cave recorded the lowest score. National parks attract visitors and local people who are concerned about conservation. Some local activities and commerce are not permitted in these areas; therefore, cultural and economic values in national parks are reduced compared to other geoheritages.

Figure 6 presents the strategic planning technique used to identify strengths, weaknesses,

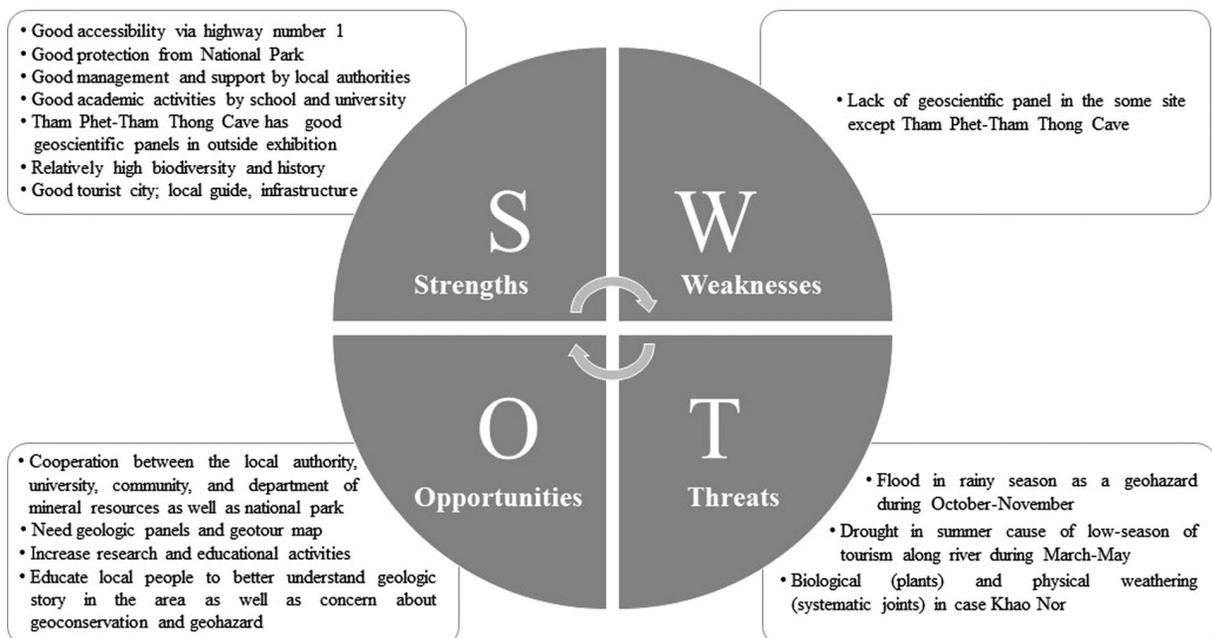


Fig. 6. The strategic planning technique used to identify strengths, weaknesses, opportunities, and threats related to the geoheritage and geotourism development in Nakhon Sawan Province.

opportunities and threats as a SWOT analysis of geoheritage and geotourism development in Nakhon Sawan Province. This area has many strengths as (1) good accessibility via highway number 1, (2) protection with National Park status, (3) management and support by local authorities, (4) academic activities by schools and universities, (5) Tham Phet-Tham Thong Cave demonstrating geoscientific panels in an open-air exhibition, (6) high biodiversity and history and (7) a great province for tourism with local guides, and infrastructure. However, some sites have weaknesses and lack geoscientific panels, which leads to difficulty in developing geotourism. This area can develop because of the opportunities given as follows:

1. Cooperation between the local authority, university, community, and department of mineral resources, as well as national park sector,
2. Create geologic panels and geotour map,
3. Increase research and educational activities,
4. Educate local people to understand better the geologic story in the area as well as concerns about geoconservation and geohazard.

Geoheritage resources should be protected from threats such as floods at the end of the rainy season during October and November, drought in summer, which is low-season for tourism along the river from March to May, as well as biological (plants) and physical weathering (systematic joints) in the case of Khao Nor.

## Discussion

Nakhon Sawan is a land of culture, both past and present, comprising many archaeological sites in the Dvaravati culture (6<sup>th</sup>-11<sup>th</sup> century C.E.). All of these sites have significant settlements related to the outstanding geologic features. Accordingly, as can be seen from the archaeological site distribution, ancient peoples always selected to settle their home or maybe city in the land that was rich in resources for their living. This study provides two hypotheses about the settlement of ancient people in Nakhon Sawan as follows;

1. Water resources: people always need water for their living and occupation, such as agriculture, fishery, transportation, as well as consumption. This hypothesis is agreeable with the location of archeological sites along the Chao Phraya river. In addition, the river could give people clay resources for making potteries as well as accessories.
2. Ore deposit: skarn is the ore deposit (i.e., iron) originated from granitic rocks contact with limestone. The archeological sites have close neighborhoods with limestone mountains in Nakhon Sawan that are far from river or water resources. The researchers gave a hypothesis suggesting that ancient peoples had more critical things to do, which were the metallurgical

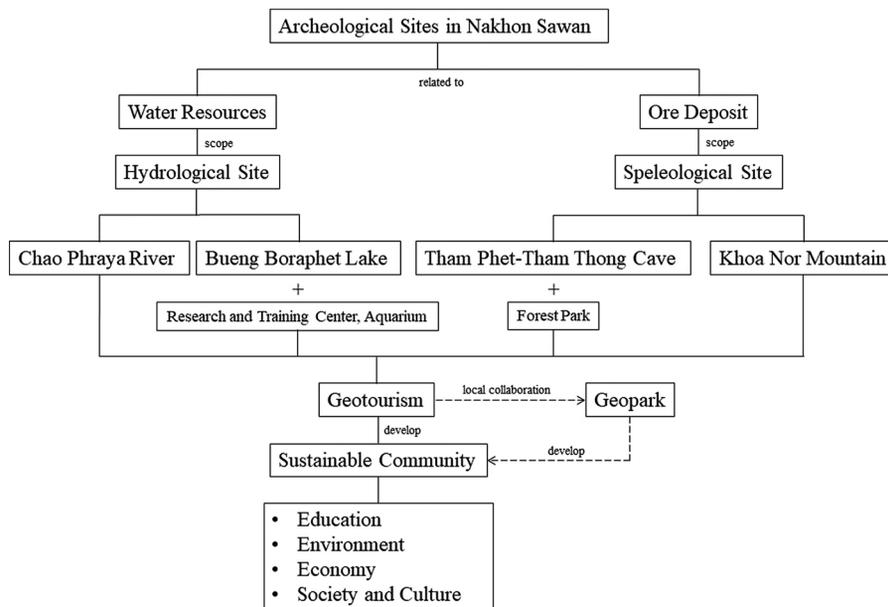


Fig. 7. The interrelationships between the archaeological sites and geology for geotourism development in Nakhon Sawan.

activities that could make them develop rapidly more than stone and wood. This hypothesis can be proved by many pieces of evidence, which describe their activities with metallurgy, especially steel smelting.

So, the archeological sites in Nakhon Sawan were always related to water resources and ore deposits (Fig. 7). This concept can make a great story-telling of this region about A+C relationships (abiotic and culture components) in the past many hundreds of years ago. Furthermore, it can be a highlight of geotourism development in Nakhon Sawan, which has many geosites connected with culture and history as well as nature. All of these geosites are very famous for local people, students, and tourists by their scientific, educational, cultural, historical, natural, aesthetic, and tourism values that can increase economic growth.

The government of Thailand is supporting the geoparks' establishment and geotourism development for local people can understand and manage their georesources for better livelihood and environment, which is the concept of a sustainable community.

## Conclusion

The archeological sites in Nakhon Sawan Province are distributed near two main geoheritage resources that are two hydrological and two speleological sites. Based on the historical evidence, the location of thirty more ancient communities related to two hypotheses for the excellent livelihood of ancient people: 1) water for assumption, and 2) metallurgy for life development. Four geoheritages in Nakhon Sawan are the famous geomorphological sites for researchers, students, and tourists. The confluence of the Chao Phraya River, the greatest meandering river of Thailand, is presented in the center of the city as a vibrant cultural area. In addition, the biggest fresh-water swamp of Thailand is *Bueng Boraphet lake*, which is caused by the Nan and Chao Phraya River. Moreover, both hydrological sites have the identity of biodiversity, which consists of many species of fishes, birds, and plants. The speleological sites consist of two areas: Tham Phet-Tham Thong cave in the south, and Khoa Nor mountain in the north. These limestone mountains were

intruded by granitic rocks resulting in the potential of skarn (ore deposits) mining. Tham Phet-Tham Thong consists of many tens of cave with stalactites, stalagmites, columns, and fascinating fossils so that this area can be a stratigraphic site also. Khoa Nor mountain is the famous structural site, karst landform dominating on the floodplain formed by strike-slip fault. All of these selected geosites in Nakhon Sawan have many terms of values by their importance and local authorities' development, such as geology, history, culture, nature, education, tourism, aesthetically, and economy. Geotourism is suitable to develop in this region for making people understand the natural composition, geoscientific significance, and reason for human settlement. Moreover, this scheme can make local people get good infrastructures, new jobs, more income through tourism activity, which are the critical points of sustainable development goals.

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## Author's contribution

The first author made 70% contributions to this paper about geologic field investigation and field observation of the archaeological sites. The inventory, characterization, classification, assessment, and discussion about geoheritage and geotourism, as well as manuscript preparation, were also done by the first author. In addition, the second author contribution about 30%, that is, checking hypotheses of results and geologic information of the study area by geologic fieldwork as well as paper verification.

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