

GEOTOURISM ASPECTS OF THE LUFENG DINOSAUR NATIONAL GEOPARK IN YUNNAN PROVINCE, CHINA

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Abstract

The Lufeng Dinosaur National Geopark in Yunnan province, China, is important part of geoheritage with a great scientific and aesthetic value. The area has been under scientific research since 1938 when the first dinosaur fossils were discovered here by geologist Bian Meinian and technician Wang Cunyi. Professor Yang announced the discovery of new early Jurassic herbivore prosauropod by Lufeng in 1941, which he gave the name *Lufengosaurus huenei*. In 2004, the area was listed as the China's National Geopark. It was opened for visitors in 2008. Besides the high scientific value, the geopark is also an important resource for science based and educational tourism. This paper briefly introduces the history of scientific research, the basic geology of the site and the most important fossils discovered here. The main characteristics, geodiversity, and geotourism of fossil geoheritage in the area are discussed here.

Keywords: Lufeng Dinosaur Valley, geoheritage, geotourism, fossils, paleontology.

1 INTRODUCTION

Geotourism is relatively a new form of sustainable tourism and has been developing rapidly in the last two decades. Its main aim is to bring tourists to geological heritage and educate them in the field of Earth sciences [1]. Geotourism as a new branch of tourism has been defined relatively recently and its definitions have been still changed and improved [2 - 9].

According to the most definitions, geotourism is a form of tourism related to geological and geomorphological sites and features, such as rocks, landforms, or fossils. It is focused on the geological heritage of an area and oriented on sustainability, conservation, education, and community benefits. As a branch of sustainable tourism, it should sustain at least the geographical character of a place. The minimising of impacts of tourism on the environment, culture, aesthetics, heritage, and the well-being of its residents can be achieved by geoconservation management [1, 10 - 14]. Dowling and Newsome [5] define geotourism as:

“Geotourism is a form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geo-sites and the conservation of geo-diversity and an understanding of earth sciences through appreciation and learning. This is achieved through independent visits to geological features, the use of geo-trails and viewpoints, guided tours, geo-activities, and patronage of geo-site visitor centres.”

Geodiversity and geoconservation

In accordance with some definitions, participants of geotourism would like to experience and learn from and enjoy world's geoheritage resources whose value is based on geodiversity [1, 15]. The term geodiversity was first used in the 1990s, but the history of the use of the principles is much longer [3]. 'Geodiversity' has been defined as 'the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landform, processes), and soil features. It includes their assemblages, relationships, properties, interpretations, and systems' [12]. As an abiotic equivalent to biodiversity, it describes the variety of earth materials, forms, and processes [12]. The main purpose of geotourism is the introduction and conservation of geosites and geomorphosites, and development of the idea of sustainable tourism [1, 4]. The term geoconservation is known from the beginning of the 21st century and means the far-seeing use and management of geological and geomorphological resources [1]. Geoconservation has been defined as “the act of protecting geosites and geomorphosites from damage, deterioration, or loss through the implementation of protection and management measures” [9, 16].

Geoparks

The idea of geoparks has been developed in the recent years. UNESCO's work with geoparks began in 2001 and in 2004, when 17 European and 8 Chinese geoparks came together. Currently (January 2016), there are 120 Unesco Global Geoparks in 33 countries [17]. There is no legal status attached to the UNESCO Global Geoparks and their heritage should be protected under local legislation [18]. The main purpose of a UNESCO Global Geopark is “to enhance awareness and understanding of key issues facing society, such as using our Earth's resources sustainably, mitigating the effects of climate change and reducing the impact of natural

disasters“[19]. Another form of geoparks may be parks at national level, such as the Lufeng Dinosaur National Park. The status of National Geopark in China means that it is approved and awarded a certificate from the central government [20].

2 LOCATION AND OVERVIEW OF LUFENG DINOSAUR NATIONAL GEOPARK AND RESEARCH HISTORY OF DINOSAUR FOSSILS

The Lufeng Dinosaur National Geopark is located in a watershed area of the Jinsha River and Honghe River on the central Yunnan Plateau, in the Lufeng County approximately 100 km to the west of Kunming, the capital city of Yunnan province. It is situated on the G56 Hangrui Expressway. Besides going there by car, it can be easily reached by buses from Kunming or Chuxiong. The Lufeng Dinosaur National Geopark was listed as the China's National Geopark No. 56 in 2004 to protect world-renowned fossils and other geological remains.

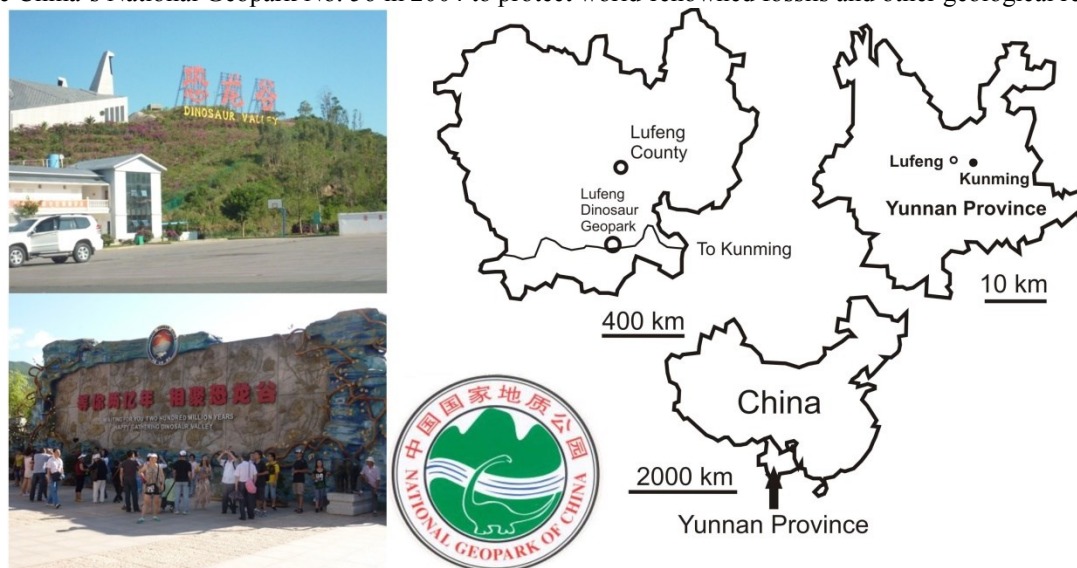


Figure 1: Entrance and geographic map of Lufeng Dinosaur National Geopark

The beginning of scientific research on the Lufeng dinosaur site can be dated to the year 1938 when one of the most famous vertebrate paleontologists, professor Yang Zhong Jian assumed the directorship of the Yunnan office of the National Geological Survey of China. In October 1938, two of his subordinates, geologist Bian Meinian and technician Wang Cunyi, stopped in the Lufeng County on their way from the Yunnanmou County to Kunming. The Yunnan-Myanmar road was under construction in Lufeng at that time. Sleeping in a village house, Bian and Wang discovered an oil lamp called „dragon bone“ which looked like a fossil. Villagers told them that this bone could be collected on the construction of the Yunnan-Myanmar Road. They understood the high scientific value of this “dragon bone”. Next day Wang found intact vertebrae near the Shawan village and informed Prof Yang and started excavating on the site. In next three months, they collected more than 40 crates of fossils.

After long time of study of Lufeng fossils, Professor Yang announced the discovery of new early Jurassic herbivore prosauropod to which he gave the name *Lufengosaurus huenei*. The specific name was given in honour of the Yang's old tutor, German paleontologist Friedrich von Huene. The *Lufengosaurus* became the first complete dinosaur skeleton mounted in China. In 1951, Professor Yang identified a large dinosaur and named it *Lufengosaurus magnus*. In the same year, he published an important work “The Lufeng Saurischian Fauna in China”.

Since 1938 there have been found 24 categories, 33 species and about the one hundred of complete dinosaur fossils. Besides the most famous *Lufengosaurus* [21 -22], it is necessary to mention fossils of other sauropodomorphs, such as *Sinosaurus*, *Gyposaurus*, *Yunnanosaurus*, *Jingshanosaurus* [23]. Also representatives of the Ornithischia group [24], and theropods were unearthed there [25 - 27]. The dinosaur fauna of the Lufeng Formation is often collectively referred to as the “Lufengosaurus fauna” [27 - 29]. The first dinosaur footprints from the Lufeng Basin were described by Lü et al. [30] and were named *Lufengopus dongi* [27].

Reisz et al. [31] described the discovery of an embryonic dinosaur bone bed from the Lower Jurassic of China, the oldest occurrence in the fossil record. Also the discovery of the earliest mammals and derived, late-surviving, non-mammalian eucynodonts, basal crocodylomorphs, and sphenodontians, which have been recorded from the Lufeng Basin collections [29, 32], is of great interest.

3 GEOLOGICAL SETTINGS

In a number of small continental basins across a large part of Yunnan Province, an extensive succession of Lower Jurassic through Cretaceous is exposed, which was a low-relief alluvial plain during the Mesozoic. The Lower and Middle Jurassic deposits of the Lufeng Basin are the most fossiliferous and famous [27, 32].

The continental red coloured sediments of the Lufeng Formation, in the Lufeng Basin, are conventionally divided into upper and lower units. Their thickness is approximately 750 m. The age of Red Bed was determined by Young [33] as the Late Triassic. More recently, the Early Jurassic age for the Lower Lufeng Formation and the Middle Jurassic age for the Upper Lufeng Formation were proposed by Sheng et al. [34]. According to the study of the stratigraphic section at Lao Changqing-Da Jianfeng in the Chuanjie Basin, Fang and colleagues shortened the name of the “Lower Lufeng Formation” to the “Lufeng Formation”, and divided it into the Shawan (Dull Purplish Bed) and Zhangjia’ao (Dark Red Bed) members. The Upper Lufeng Formation was divided into the Chuanjie, Laoluocun, Madishan, and Anning formations [27, 35].

4 GEOTOURISM AND GEOCONSERVATION

The total area of the Lufeng Dinosaur National Geopark covers 260 km² and incorporates several types of geological and geomorphological resources with a high scientific, educative, aesthetic as well as touristic value, such as paleontological remains, a typical stratum section, Danxia morphological landscape, ancient mining remains, and many others. Geoheritage of the park is mainly distributed in the Dinosaur Mountain, Shihuiba, Chuanjie, Wutai Mountain, and Heijing. The geological and geomorphological resources in the geopark can be divided into 7 types, 28 subtypes and 51 forms, including human landscape resources. They include 358 spots of geological landscape resources that belong to 6 types, 22 subtypes, and 39 forms; 178 spots of human landscape resources that belong to 1 type, 5 subtypes, and 12 forms; 22 spots of animal and plant resources that belong to 2 forms; more than 1300 items of the historical relic collection.

The most important part of geoheritage of the park is formed by Lufeng dinosaur fauna fossils which are distributed in two main areas:

- Lufeng Basin, where more than 110 pieces of dinosaur skeletons were found in the sediments of the middle and lower part of the Lufeng Formation of the Early Jurassic.
- Chuanjie Basin, where 15 pieces of dinosaur skeletons were found at 8 sites in the horizon of middle and lower parts of the Lufeng Formation and a lower part of the Upper Lufeng Formation.

The main geoheritage of the Lufeng Basin area is created by the Lufeng Dawa Dinosaur Mountain which covers an area of about 2.25 km² and is known as the first site where the “Lufeng Saurischia fauna” was discovered. It is a distribution area of fossils and a site of original section.

It was listed as a national conservation area of ancient vertebrate by the State Council in 1961. In 1998, it was listed also as a provincial conservation unit of major cultural relics.

The Jurassic dinosaur site in the Annahe Dinosaur Mountain, which was discovered in 1995 and where hundreds of fossils of dinosaurs have been well preserved, is the main geotouristic attraction of the geopark. The park was opened in the year 2008 and its main purpose is to preserve and introduce the area where dinosaur fossils were discovered and unearthed in the largest quantity, with the most complete skeletons and the richest species. An enclosed excavation site named the Lufeng Dinosaur Quarry of China is the core area of protection.

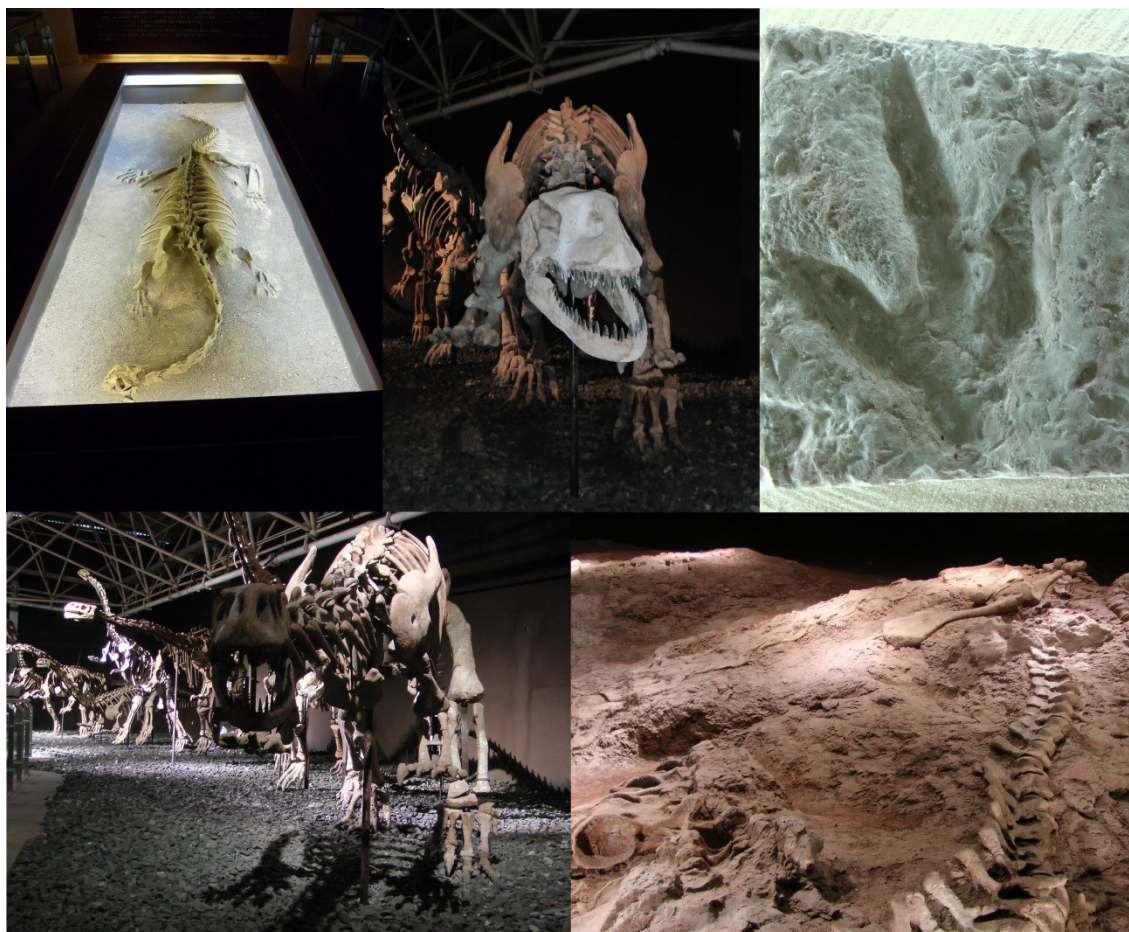


Figure 2: Photographs of inside exhibitions of dinosaurs

More than 30 sets of individual dinosaur fossils are exhibited there. A walkway allows visitors to look at each group of partly excavated bones in the soil. Some part of the walkway is built from the glass and allows looking down and seeing fossils below the visitors' feet.

Inside the exhibition hall, also a complete, dinosaur individual fossil of the "*Lufengosaurus huenei*" can be found, which was excavated from the Dawa Mountain, Lufeng County, in 1938. In the pavilion, there are also over 60 sets of restored and mounted dinosaur skeletons. It is possible to see a huge amount of the teeth, skulls, vertebrae, and other parts of the dinosaurs' skeletons in the show-cases with educative labels both in Chinese and in English. A workshop where visitors can watch how bones are excavated from the earth and cleaned is an inseparable part of the exhibition hall with a high educative value. The real local fossils are accompanied with numerous tables, diagrams, and pictures of the dinosaurs from around the world. In surroundings of the pavilion, there is a large amusement park with many attractions. Situated around the lake in the hills many life-size dinosaur statues can be seen.

The geoheritage of the Lufeng Dinosaur National Geopark bears unique and specific features of high scientific significance for studying the origin, evolution, and extinction of early reptiles, the geological history and stratum comparison. That's why all parts of the geopark are preserved systematically and completely. The geoconservation of the park is managed with the vision to effectively protect resources for future scientific research and reasonable utilization.



Figure 3: Photographs of Lufeng Dinosaur Valley Entertainment Park

5 CONCLUSION

Geoconservation management of geosites must differ depending on the type of site. Gray suggests a physical barrier for in situ preservation as the best conservation method for fossil geosites. As an example he offers the Fossil Quarry site in the Dinosaur National Monument in Utah, USA, where the quarry exposure is covered by a visitor centre / research facility [12].

Such kind of conservation play also important education role as an inseparable part of geotourism. An interactive introduction to geological values is another important role played by geotourism. According to Bringer [36], a specific natural environment is attractive for tourists if fulfils the criteria below:

1. the destination bears unique, special features,
2. there is a connection between the destination and experience / adventure,
3. the destination connects the past and present of the location,
4. the destination answers critical questions of the given area,
5. the exchange of information is realised by telling short stories instead of scientific explanations [1].

Following the criteria defined above, we can state several conclusions. The Lufeng Dinosaur National Geopark uses for the conservation of geoheritage suitable methods, which play a role in the preservation of fossils in situ as well as other roles important for the development of geotourism of the locality, such as education or entertainment, and also allows continuing the research scientific work. The criteria 1-4 are fulfilled undoubtedly.

As an example, we can mention just several facts which make this geosite unique:

- existent span of discovered fossils is very wide,
- co-existence of such a huge variety of dinosaur species and early mammals is very rare,
- preservation of dinosaur individuals even the most fragile bones is very high,
- concentration of the fossils on site is rarely high – in a section of 3,400 square meters, over 30 sets of individual dinosaur fossils and snake-necked turtles have been unearthed and there are still nearly 400 more to be excavated.

The only criterion no. 5 is not fulfilled definitely because most displays bear highly scientific explanations, and a strong story is lacking. From the geotourism point of view, the geopark forms a unique tour site which combines exhibitions of fossils of dinosaur and hominoid as well as other geological landscapes, human landscapes and national customs, and where it is suitable to widely develop geological tourism and other tour activities.

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