Geodiversity and Geoconservation in Yuanmou Basin, Yunnan Province, China

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Abstract. Geodiversity is considered as abiotic diversity, and it is the foundation of geopark, geotourism and geoconservation. Yunnan Province is the typical area abundant in geodiversity in China. Geodiversity of Yuanmou Basin, which is located in North Yunnan, possesses scientific, cultural, aesthetical, ecological values. However, there are some problems, such as underexploitation, inadequate protection, even destruction in the area. Research of geodiversity will provide a new idea for sustainable development in Yuanmou Basin.

1. Introduction

Geodiversity has been considered as one of the core elements of World Heritage as well as biodiversity for more than thirty years [1]. Although a large number of natural heritage sites and national parks depend on geological foundations, geodiversity is far less widely concerned about than biodiversity. In recent years, with the rise of geological tourism and geoparks, geodiversity is becoming more and more important in the development and protection of geoheritage [2].

Yunnan province, located in southwest China, is known as the "museum of Natural Geology" because of its geodiversity. In this paper, Yuanmou basin, located in northern Yunnan province was taken as an example to expound the connotation, significance and development status of geodiversity (figure 1). It aims to provide new ideas for the sustainable development of this area and similar areas.

2. Development and protection of geodiversity in Yunnan province

Yunnan province is located in the collision zone between Eurasia plate and India plate, which has created rich geoheritage resources through long-term internal and external dynamic process. It is a typical region with extremely rich geodiversity in China. The fundamental causes of most proud biodiversity and ethnic diversity are closely related to geodiversity in Yunnan.
As a natural geological museum, Yunnan almost covers all types of geoheritages. According to "important geoheritages investigation in southwest China (Yunnan)" conducted by the China geological survey in 2012-2015, there are 806 important geoheritages, including 36 world-class level and 185 national level geoheritages. Famous geomorphologic landscapes include Three Parallel Rivers, Tiger Leaping Gorge, the Stone Forest, Jiuxiang Cave, Meili Snow Mountain, Yulong Snow Mountain, Yuanmou Earth Forest, Liming Danxia Mountain and so on. Distinguished geoheritages consist of Chengjiang Fossil Site (Cambrian period), Luoping biota (Triassic period), Lufeng dinosaurs, Tengchong volcanic geothermal field, Dongchuan debris flow, et al. These rare geoheritages are precious and non-renewable resources for the study of earth evolution and life evolution, for the promotion of geoscience research and popularization, for the development of local tourism and for the coordinated development of economy and society.

However, many important geoheritages cannot be effectively protected due to the lack of funds because of limited financial resources.

3. Geological background in Yuanmou Basin
Yuanmou Basin is located along the Jinsha River in northern Yunnan Province. It is about 30 kilometers long from north to south and averaging 7 kilometers in width from east to west. It is about 1100 meters above sea level. The Longchuan River flows into Jinsha River from south to north in the west of the basin. The western margin of the basin is a low ridge composed of Precambrian metamorphic rocks, with an altitude of about 1400 meters. The eastern part is composed of the Jurassic and Cretaceous red strata of the Mesozoic era, commonly known as Dongshan, with the highest point reaching 2700 meters above sea level.

The conversion place of basin-mountain is Hongge-Yuanmou fault zone with obvious fault cliff landform. The Cenozoic strata, especially the Yuanmou Formation in the early Pleistocene, are well developed [3]. Yuanmou Formation is one of the standard sections of early Pleistocene in southern China. In the upper part of the Yuanmou Formation, tooth fossils and cultural remains of Homo erectus yuanmouensis before 1.7 Ma as well as a large number of mammal fossils were found, and 29 genera of 18 families and 6 orders were identified, accounting for 86.7% of the extinct species [4-5]. The lower and upper Pliocene sedimentary layers of the Yuanmou Formation are dominated by fluvial and delta facies, consisting of gravel layer, sand layer mixed with thin clay layer and clayey layer, which has developed the most famous soil forest landform in China [6-8]. Yuanmou laterite is also
developed in the basin, which can be divided into weathering crust laterite, groundwater laterite and slope laterite, recording the past environmental evolution of the basin -- from the humid and hot climate of the late Cenozoic era to the warm and dry climate of the modern era [9-10].

From the above, geodiversity is very significant in Yuanmou basin, covering a variety of geological phenomena, such as three type rocks (sedimentary rocks, metamorphic rocks and magmatic rocks), strata, structure, paleontology, paleoanthropology, and soil. Most worthy of mention is Homo erectus yuanmouensis (the unique and definite early human fossils of human cultural sites in China) (figure 2a) and the soil forest landscape with a great appreciation value (the unique national 4A scenic spot of soil forests) (figure 2b).

![Figure 2. Homo erectus yuanmouensis site (a) and Yuanmou Earth Forest landscape (b)](image)

4. Geodiversity values
The geodiversity of Yuanmou basin has multiple values of science, culture, sightseeing, ecology, science popularization and education.

4.1. Scientific value
Yuanmou Basin is the fossil site of the oldest tool-making "real man" in the world - Homo erectus (commonly known as "Yuanmou man"), which has attracted much attention in the international paleoanthropology field. It is of great scientific significance to explore the beginning of Asian mankind and understand the origin and evolutionary mechanism of mankind.

Yuanmou Basin is also the naming place of "Yuanmou (Ma Jie) fauna", a representative mammal group in the early Pleistocene. In addition, it is as well as the standard section of late Cenozoic fluvial and laculofacies strata in southern East Asia, which is an important information base for studying the paleogeography and paleoclimatic environmental changes in this area.

4.2. Cultural value
As early as 1.7 Ma ago, the ancient ancestors of the East, “Yuanmou man” had already multiplied and lived here, leaving behind the splendid civilization footprints of their ancient ancestors. Later in the middle and late Paleolithic ages, Xiaohengshan Culture and Sijiacun Culture appeared respectively, and in the Neolithic age, there also appeared a large number of traces of human civilization in Daduzi, Madahai, Longjie and other places. This branded Yuanmou with indelible civilization root and made Yuanmou long history and splendid culture for the world attention.
4.3. Ornamental value
Yuanmou soil forest has a unique aesthetic value, because of its tall and straight, graceful and beautiful form; it has the beauty of color because of its gorgeous and changeable colors; it has artistic conception beauty because of its wild and rough; it is endowed with changeable beauty because of the changing seasons. These unique beauty, not only attract many domestic and foreign tourists to view and photography, but also have been an important film base. Yuanmou soil forest occupies an important position and role in the national soil forest tourism resources.

4.4. Ecological value
Yuanmou Basin is located in the dry and hot valley area, with hot climate, scarce vegetation, drought and little rain. Most of the rainfall is in summer, and most of it is rainstorm. Due to the special climatic characteristics, scarce vegetation and poor soil, it is easy to cause soil and water loss in Yuanmou district, especially in the soil forest area. Nowadays, some soil forests gradually become mounds or even die out because of soil erosion and heavy rain. Human disturbance also causes great damage to the soil forest.

Beyond the outer beauty of Yuanmou soil forest is the result of the disharmonious relationship between man and nature and the great changes in the environment. Soil forest has the typicality and model of soil erosion research and can be used as a good research object of soil erosion. Through the research, we can fully understand the causes of soil and water loss and master the law of soil and water loss, so as to establish good ecological protection measures and ecological construction.

4.5. Science popularization and education value
As mentioned before, it contains a wealth of geological information in Yuanmou basin. Homo erectus yuanmounensis Museum and Soil Forest Scenic Spot are excellent places to carry out science popularization work, which can make people understand the evolution of the earth, the origin of human beings and the changes of the environment and other knowledge, so as to achieve the effect of teaching through entertainment and travel.

5. Geoconservation
5.1. Underexploitation and ineffective protection
Due to the lack of understanding of the geodiversity in Yuanmou basin, the protection of geoheritage resources is insufficient, and many important geological phenomena are destroyed. For example, two teeth of Homo erectus yuanmounensis were not archaeological excavations, and the hill of discovering the teeth has disappeared. So the original burial place is difficult to verify, and the study of formation with the original fossils unearthed formation cannot ensure 100% fit defects. It highlights the formal extremely importance of archaeological excavations and site protection.

Another example is Yuanmou soil forest, which is distributed in many places. Except for Langbapu soil forest, Wumao soil forest and Banguo soil forest, scenic spots have been set up to protect them. The rest are in a barren state with severe human destruction, and many places have been removed or buried (figure 3a). Even though the soil forest in the scenic spot is not hard enough due to its semi-cemented formation material, it is easy to be eroded by water flow or affected by earthquake, and some soil pillars are degraded or even dumped from time to time (figure 3b). Other geological phenomena are more neglected and are increasingly being destroyed by man or nature. These geological phenomena are non-renewable resources, until it is too late to carry out rescue protection.
5.2. Geodiversity research can provide a new idea for the sustainable development of Yuanmou basin. Geodiversity is the basis for strengthening the conservation of geoheritages and developing geotourism. In order to achieve orderly development and effective protection, it is difficult to achieve much without the guidance of scientific thinking and the support of scientific research. At present, Yuanmou soil forest is applying for the national geopark. To fully understand the function of geodiversity to nature, human and society, and to promote the protection of geoheritage resources to the level of geoconservation through the development of geotourism can provide a new idea for the sustainable development of Yuanmou Basin.

A large number of geological scientific researches have been carried out in Yuanmou Basin, mainly focusing on Cenozoic strata, paleomagnetism, paleoenvironment, paleontology, anthropology and other fields. The basic data are abundant, but the research on geodiversity is still blank. The study of geodiversity in this area can reveal the huge amount of geological information and the law of geological evolution in the formation of Yuanmou basin, and can also put forward a new direction for the study of geological science in this area.

The study of geodiversity will greatly contribute to the planning and utilization of geoheritage resources and geoconservation in the area. Yuanmou basin contains a wealth of geological information, especially brings up Homo erectus yuanmounensis site and soil forests. However, Homo erectus yuanmounensis site has not been effectively protected, and the soil forests have been seriously damaged by human and natural destruction, while other geological phenomena have been neglected.

Yuanmou Basin is an important vegetable producing area in Yunnan province. Its basic conditions are the dry and hot valley climate and diverse soil, which are determined by the geodiversity. Agricultural development depends on land. Many significant geological sites or even soil forest zones are buried or removed for agricultural cultivation. on the opposite, soil forests are the landscape carrier for tourism. In the face of the contradiction between the two, we should consider the development of Yuanmou from the perspective of understanding the function of geodiversity to nature, human and society and the service of abiotic ecosystem closely related to geodiversity, which can provide a new idea for the construction of ecological civilization and sustainable development in the area.
It can enable people to understand the evolution of the earth, the origin of human beings and the change of the environment to fully excavate the extremely rich geological information contained in the geodiversity of Yuanmou basin. Homo erectus yuanmounensis museum and soil forest scenic spots are the excellent carrier. Yuanmou Basin is a popular place for many primary and secondary school summer camps, which can provide popular science education materials.

6. Conclusions
As much an idea as biodiversity, geodiversity is a scientific tool for nature conservation. But at present, the idea still needs to be further popularized and promoted. Yunnan has unique advantages in geodiversity, of which Yuanmou basin is just a microcosm. The geodiversity of Yuanmou basin has multiple values such as science, culture, sightseeing, ecology, science popularization and education, which provides good conditions for the development of geotourism. In addition, the protection of geoheritage resources is promoted to the level of geoconservation, which can provide a new idea for the sustainable development of Yuanmou Basin.

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