Resource Features of the Hexigten Geological Park in Inner Mongolia and its Sustainable Development

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Abstract: The Hexigten Geological Park in Inner Mongolia is characterized by its landscapes generated by the movement of glaciers and volcanic eruptions dating from the Quaternary Period. The Ashihatu granite forests, clusters of rock mortars of Qingshan, and glacier relics on the Huanggangliang ridge are geological resources of national and world-wide significance. In this paper the author has briefly introduced the resource features of the Hexigten Geopark, analyzed the leading problems in its development and offered suggestions for its sustainable development.

Keywords: Hexigten, geological park, resource features, sustainable development

1 A Survey of the Hexigten Geological Park
The Hexigten Geological Park lies in Hexigten Banner, northwest of Chifeng City in the eastern part of Inner Mongolia Plateau, where the Inner Mongolia Plateau, Daxinganling Mountains and Yanshan Mountains meet. It is 650 km away from Beijing, the capital of China. It covers an area of over 5000 km², which accounts for 8 percent of the total area of Hexigten Banner.

The frequent movement of glacier and molten rock since the ancient Quaternary Period (about 1,750,000 years ago) has generated its unique and miraculous landscapes. Its diversity of geological features and relics are manifested by Ashihatu granite forests, Qingshan rock mortar clusters and granite peaks, glacier relics of the Quaternary Period on the Huanggangliang ridge, cirques on flat-topped mountains, volcanoes on the Dali lake, hot springs, grand canyons of Xilamulun, and sands of Hunshandake. There are 8 categories of geological landscapes in the park, which combine in one the geological features of tectonic relics, glacier relics, granite landscapes, volcanoes, hot springs, deserts, grasslands, rivers, and lakes.

The Hexigten Geological Park, established in March, 2001, is one of the first 11 national geo-parks approved by the Ministry of National Land Resources of China. It got its approval from UNESCO as a world geo-park in 2005. The geo-park is noted for its superb geography, natural environment and well-preserved geological relics, which is characterized by its uniqueness, rarity, typicality, beauty and diversity. It is a natural museum for the rise of Inner Mongolia Plateau and the evolution of the envi-
2 Resource features of the Hexigten Geological Park

2.1 The Ashihatu granite forests

Arshihaty, in the Mongolian language, means precipitous rocks. The Ashihatu granite forests are 40 km away from the highest peak of Daxinganling Mountains at the altitude of about 1700 m on the northern hill, with its ridge stretching northeastwards in an area of 5 km². These granite forests, because of the effect of ancient glaciers during the Quaternary Period, have evolved into peaks with sharp edges or corners, and are distributed on the ridge either in line or separately. These peaks look like those stone forests in Lunan, Yunnan Province but these are formed out of granite, which is unique both geologically and geographically in the world.

2.2 The rock mortar clusters of the Qingshan Mountains

On the surface of the summit of the Qingshan Mountains and among the granite peaks, a special landscape, granite mortar clusters have evolved. There are about 1,000 well-preserved granite mortars in typical shapes, large-scale mortar clusters which are rare in the world. The mortars evolved out of granite hill tops with small openings and large hollows marked with spiral streaks. These mortars resemble those kettle-shaped holes formed in river beds. This type of landscape is rare in the world and only found in some parts of China. The Hexigten Geo-park has the largest scales and most types of granite mortars.

2.3 Geological relics of glaciers of the Quaternary Period on the Huanggangliang ridge

Huanggangliang is the summit of Daxinganling Mountains with an altitude of 2036 meters, composed of 27 peaks stretching from the east and to the west. The diverse landscapes of the Quaternary Period glaciers have been perfectly preserved in the area of Huanggangliang. Both sides of the ridge are dotted with cirques, U-shaped valleys, sharp-cornered peaks, end moraines, side moraines, streaked stones, gravels, -- relics of the glaciers. The relics of the Quaternary Period are, so far, the best preserved, most diverse and most valuable.

2.4 The cirques on the flat-topped hills

Cirques on the flat-topped hills in the geo-park are located in the Town of Wanheyong, with an average altitude of 1,370 meters. Hundreds of cirques, relics of the Quaternary Period glaciers, are distributed among the hills and contribute to the formation of sharp ridges and sharp-cornered peaks. The cirques on the flat-topped hills, are large scale cirque clusters and are the largest in number, best developed, and best preserved in China. Their formation covers the largest number of geological times. The discovery of the cirques has proved to be an extremely valuable source of data for the study of the evolution of the environment of the Inner Mongolia Plateau. The value of this...
area contributes to a base for geological research in northern China.

2.5 Dalinaoer volcanoes

Dalinaoer is the second largest inland lake in Inner Mongolia. It is located in the fault belt of the Xilamulun River. It is an inland lake formed, on the basis of a tectonic lake during the tectonic subsidence, due to the blocking of the molten basalt. On the banks of the river are scattered geological relics of volcanoes including terraces of molten rock, craters, cones and micro landscapes. Volcanic eruptions occurred between the Pleistocene epoch, 100,000 years ago, and the Holocene epoch, 10,000 years ago in the area. Dalinaoer volcanoes are one of the nine grand volcano clusters in northeastern China. They represent typical examples for the study of the working mechanism of volcanoes in northern China and the volcanic zones around the Pacific.

2.6 Hot springs

Scattered on the diluvial sedimentary sectors of the Hexigten Banner, with an area of 1 km², are ponds with hot springs. The ponds have a daily reserve of 3,017 tons of hot water, with a steady discharge of hot water of 2,592 tons per day. The temperature of the water is around 83 degrees Celsius. The rise of the Inner Mongolia Plateau and the eruptions of the volcanoes in the Daxinganling Mountains generated the broken belts. The penetration and circulation of water from the rains, porous rocks and clefts through the broken belts, was heated in the depth of the crust, collected in the permeable broken belts of granite, and rose through the clefts to the surface of the earth to form hot springs. The mechanical function of the hot springs has special effect on the circulatory system, the digestive system and locomotors system of the human body. The hot springs have been rated as highly effective quality springs by Mineral Springs in China, with the water hailed as holy water from enchanted springs of the Orient.

2.7 The grand canyon of Xilamulun

In the Hexigten Geo-park, there is a deep fault belt named Xilamulun. The fault belt stretched eastwards along the western Liaohe River to the eastern part of Liaoning Province, and westwards along the Xilamulun River to the Gobi Desert, passing Dalinaoer, Wendiurermiao and northern Baiyunebo. The fault belt is tens of kilometers wide and more than 1,000 kilometers long. The profiles of the two sides of the fault, gravitational deviation, navigational magnet abnormality isopleths are distributed in totally different directions. The structures of the crust and rock bands on both sides of the fault zone are different. To many geologists, the fault zone is the convergence of Siberia and Sino-Korean plates, and is significant for the study of the brief history of the vast area between the two plates.

2.8 The Hunshandake Deserts

The Hunshandake Deserts are mainly found in the western part of the geo-park. The deserts, typically permanent and semi-permanent, came into being in the Pliocene epoch when the globe was in an epoch of glaciers of the Quaternary Period and the Tibetan Plateau was on the rise, as a result of both the climatic fluctuation and fresh tectonic movements. The deserts have recorded the changes of the climatic conditions since the Tertiary Period. They are like a lab for the study of the changes of climate in
the north of China and the whole world.

3 Sustainable development of the Hexigten geo-park

Ever since the geo-park was established, great progress has been made in the construction of scenic spots, designing of tourist products, management of the scenes and marketing. A number of problems arose from its large area and widely distributed scenic spots. Each department within the geopark management should outline its obligations and rights. The tourists would be better served providing the tourist guides have adequate professional knowledge and training. There are clashes between the protection of the geological relics and tourist development. Conflicts between the fast-growing demand for tourism and the protection of geological relics needs to be resolved immediately. To resolve some of these issues, the author offers the following suggestions:

3.1 To optimize the managerial system of the geo-park

At present the geo-park is under the administration of the Ministry of National Land Resources of China, but the national reserves, tourist attractions, forest parks and tourist management, etc., are in the charge of different offices whose functions and mutual relations are entangled. It is evident that the management is far from perfect. In order to improve the management, the geo-park needs an administrative committee to strengthen its management, coordinate the national parks, tourist attractions, forest parks and tourist management, and avoid overlapping or separate management without cooperation. It is necessary to have experts from such related disciplines as geology, environmental science, who can advise and make professional suggestions. The guiding principle is that the geo-park is directed by the government but operated by the enterprise with community participation. When the rights for management of the enterprise are secured, the functions of macro-direction of the government, coordination of the offices, supervision and administration in the industry should also be strengthened. A long-standing mechanism of management and protection of the resources should be established to safeguard the overall development which is both sustainable and coordinated.

3.2 To limit the number of tourists on the basis of its environmental capacity

The central part of the Hexigten geo-park for the protection of geological relics is also a tourist resort. Recent years have seen the steady increase in the number of tourists, especially after the successful bid for the status of a world geo-park. Because of the ever-growing number of tourists, the central part of the geo-park has been over-exploited, leading to the damage to the authenticity and intactness of many of the geological relics and the ecological environment.

Therefore, it is necessary for the management to calculate exactly the environmental capacity for tourists and its tolerance so that the number of tourists can be regulated during the operation time, and the tourists can be rationally directed to different parts of the park. As a result, the goal of sustainable development is met and the geological relics and ecological environment will be well protected without a decrease in the number of tourists. In the well-known scenic spots, the number of tourists can be controlled by booking visits in advance, for instance, in the Ashihatu gran-
ite forests, the rock mortar clusters of Qingshan, and hot springs. In the less known scenic spots, such as the grand canyon of Xilamulun, and the Hunshadake deserts, promotion will make them better known and tourists can be diverted to these areas, resulting in a balanced development of all the spots with better environment for the tourists.

3.3 To encourage community participation in the management

The protection of the geo-park and development of tourism cannot be effective without the participation of the community. The geo-park can be managed with coordinated efforts, community participation included. Community participation in management can not only help to avoid confused managerial objectives and conflicting interests of different offices, but also help to promote employment and to increase the income of the people in the community. Their awareness of and enthusiasm for the protection of geological relics will also be enhanced. It is one of the important measures to realize the sustainable development of the geo-park.

The natives in the vicinity have lived there for generations, and know the relics very well. It is essential that the local people participate in the protection and management of the relics. To enhance community participation, public media should be employed to explain to the local people how the volcanic landscapes were formed and their underlying causes. They should be informed of the value for tourism and the medical effect of the mineral water. This will encourage incentives to protect the geological relics. They should be aware, with the guidance of the government, that they are part of the tourist industry, and can share the benefits tourists can bring to them with the entrepreneurs for tourism as well as the handful of managers. They can be the genuine beneficiaries and protectors of the geo-park and tourism.

3.4 To qualify the personnel in the industry

The Hexigten geo-park contains a variety of highly specialized geological relic sights. It will require people with specialized knowledge. It is essential that personnel in the trade should be equipped with the expertise in geology, environmental science, tectonics, and biology. The personnel in the geo-park need to become qualified. There is a shortage of specialized managerial personnel and ecological experts. As a result, more money should be invested in the training of talents by the Hexigten geo-park and its related administration. More experts in geology and botany as well as managerial personnel of tourism should be employed for the maintenance and protection of the geological resources for tourism. Training programs should be provided for the people engaged, and standards should be set. Vocational training of the personnel engaged, along with the improvement of the management and service of them, is the prerequisite for popular science education, scientific research and protection of the geo-relics and the only way for sustainable development of the geo-park and service for tourist to greatly improv.

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