The evaluation and development of the geoheritage landscapes in Dalian Jinshitan National Marine Park

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Abstract: The geoheritage landscapes in Jinshitan scenic area include the standard Chinese Sinian strata, the typical sedimentary geology (such as: crack), fossil of trilobite and sea-worn landform landscape. Various types of geoheritage landscapes with scientific value, aesthetic value and popular science education value are widely distributed in the scenic area, and they are the ideal places for people to enjoy the beautiful landscapes, go sightseeing, do the geological research and carry out the popular science tourism. For further development of the geoheritage landscapes of Jinshitan scenic area, the paper puts forward the suggestions for development and protection: (1) Improving the management system and professional team; (2) Doing the general survey of the geological resources, and establishing the vendor library; (3) Strengthening the protection of geoheritage landscapes; (4) Carrying out geological tourism, and designing reasonable routes of geological tourism; (5) Establishing and improving the interpretation system and signage system of geopark; (6) Strictly controlling the environmental capacity of geopark, and protecting the precious geoheritage landscapes; (7) Integrating the tourism resources in the scenic area, and achieving the comprehensive development of tourism.

Keywords: Jinshitan scenic area; Dalian Coastal National Geopark; geoheritage landscapes; development and protection; geological tourism

1 Introduction

Geopark is a new way to protect the world natural heritage and the base of geological research and popularization. What’s more, the geopark provides a place for sightseeing and leisure.

The main body of the geopark is the geological relics. With a characteristic ornamental value, it together with the natural biology constitutes the unique ecological environment available for people to experience and the “sealed book” available for
people to interpret the story of the earth to attract tourists. The main function of geopark is to protect the geoheritages, to develop the popular science education and to provide a place for sightseeing. The establishment and development of geopark can promote the development of tourism and local economy, so as to protect the geoheritages and ecological environment more effectively. China leads the world in the construction of geoparks. As of September 2017, there are 206 national geoparks in China.

Dalian Coastal National Geopark is one of the fourth batch of national geoparks approved in August 2005. Located at the territory of Jinzhou district and Zhuanghe of Dalian, it’s divided into three parks, among which Jinshtitan Park is the most important one. The park, which is based on coastal zone geology and sea-worn landform, supplemented by stratotype section, biostratigraphic section and typical geological structure landscapes, and echoed with the marine life and cultural landscape, is a comprehensive geopark with the functions of sightseeing, adventure, leisure vacation, and recuperation in summer. In particular, the Jinshtitan scenic area was formed in the Sinian period of 600 million years ago, and its coastal reefs are peculiar and varied in shapes. It condenses the evolution of geology and earth of the Sinian period 600 million to 300 million years ago. Old sedimentary strata, after several changes of geological structure, and after the abrasion of ten million years, finally formed the plentiful coastal landscapes, stratotype sections, fossils and typical geoheritage landscapes. So the park known as the "God’s Sculpture Garden" has become a natural textbook for studying the old coast and the world-renowned base for geological research.

The geological phenomena of Jinshtitan Park have high scientific value in paleontology, petrology, tectonics, geology and so on. Therefore, the research of geoheritage landscapes in Jinshtitan Park contributes to the understanding of the evolvement and formation mechanism of characteristic geological structure in Dalian coastal region. The change of the geographical environment in northern coastal areas of China helps to improve the level of environmental awareness and quality education, popularize the scientific knowledge of geology, promote the development of local geological tourism.

2 Study area

Jinshtitan Park is located in the southeast of a famous tourist city, Dalian of Liaoning province in China. The study area lies between 39°03′01″-39°09′27″N latitudes and 122°01′37″-122°10′30″E longitudes (Figure 1). It has a land area of 89.69 km² and a coastline of 30 km. The area and border of the park: the touring district of “Jinshtitan” Park is situated at Jinshtitan street of Jinzhou district, facing the Yellow Sea on the southeast and 37km away from the center of Dalian on the southwest.

This area is a part of the Dalian Jinshtitan National Tourist and Holiday Zone. It is an ideal seaside resort in northern China that abuts against the mountain and sea. It is known as the small Jiangnan in the northeast of China due to four distinct seasons and the warm temperate semi-humid climate, being cool in summer and warm in winter. Mainly composed of blue sea, beach and reef, Dalian Jinshtitan National Tourist and Holiday Zone is an international holiday resort for entertainment, sports,
leisure and vacation. It’s a national AAAAA tourist attraction, and was rated as one of the 40 most beautiful spots in China by CNN Radio. The park, adjoining the city with perfect catering and lodging, shopping and entertainment, medical care and other facilities, is the ideal place for scientific research, popular science education, sightseeing and leisure vacation.

3 The types and characteristics of geoheritage landscapes in Jinshitan scenic area

The geoheritages that are attractive to tourists have been named as the geological landscapes by tourism geologists. The geological landscape is a special part of the geological relics, which refers to the morphology of geological relics that is exposed on the surface of the earth (including the "cave") constitute the landscapes of different sizes and shapes, is to provide the landscape with ornamental and sightseeing value, a common tourism resource, and the most important material base of geopark.

3.1 The types of geoheritage landscapes

The geoheritage landscapes in the park are rich and typical. The seven types of tourism geology resources are classified according to *Guide to overall planning of national geopark*, and most of them are in Jinshitan coastal geopark (Table 1). Some geoheritages are very important in the geological history of northern China.

3.2 The characteristics of geoheritage landscapes

3.2.1 Sinian strata (600 million-800 million years ago)

Sinian strata is first established in China, and Sinian is the ancient Indian name of China, so the Sinian strata is a standard stratum in China. It's more common in the
Table 1 The type of geoheritage landscapes in Jinshitan scenic area

<table>
<thead>
<tr>
<th>Class</th>
<th>Main class</th>
<th>Subclass</th>
<th>The name of typical geoheritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology</td>
<td>Geological sections</td>
<td>Stratotype sections</td>
<td>Sinian system Chang ling zi sub-group, Nan guan ling sub-group, Gan jing zi sub-group, Ying cheng zi sub-group, Ma jia tun sub-group, Xing min sub-group, Xing min sub-group, Cui jia tun sub-group</td>
</tr>
<tr>
<td>Geological structure class</td>
<td>Structural features</td>
<td>Fold, deformation</td>
<td>Recumbent fold, inverted anticline, the inverted anticline turned to invented syncline, disharmonic fold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fracturing structure</td>
<td>Jinzhou fracture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sedimentary structure</td>
<td>Crack stone, raindrop imprint, rock salt, pseudomorphic, gray stromatolite, purple stromatolite, fossil</td>
</tr>
<tr>
<td>Paleontology class</td>
<td>Paleontology</td>
<td>The preservation of the paleontology relics.</td>
<td>Cryptomedusoid, trilobite, armenoceras, graptolite, fossils of algae</td>
</tr>
<tr>
<td>Mineral and mineral deposits class</td>
<td>Typical mineral</td>
<td>Non metallic mineral resources</td>
<td>Flux limestone, cement limestone</td>
</tr>
<tr>
<td></td>
<td>The landscape of marine landform</td>
<td>Marine abrasion landform</td>
<td>Marine stack, sea cave, sea-worn arch bridge, sea-worn stone forest, sea-worn pictographic stone</td>
</tr>
<tr>
<td></td>
<td>marine abrasion landform</td>
<td>Structural landform</td>
<td>Valley, sparkling landscape</td>
</tr>
<tr>
<td>Water landscape</td>
<td>Natural water</td>
<td>Coast</td>
<td>Barrier free coast, barrier coast</td>
</tr>
</tbody>
</table>

Source: According to Planning of Dalian Coastal National Geopark

stratigraphic section of this area. Many sinian strata are named after the place names. For example, the Nan guan ling sub-group and the Da lin zi sub-group, Gan jing zi sub-group, Ma jia tun sub-group, Xing min sub-group and Cui jia tun sub-group, etc. These old strata (Figure 2) are very typical in our country, especially the successive sedimentation of Sinian and Qingbaikou system, which are relatively rare at home and abroad and draw huge internationally attention from geologists. After establishing the international standard section, it can be regarded as the high-class geological practice base and the ideal place for geological research.

3.2.2 The standard structural features

Multiple tectogenesis in geologic history have shaped medium and shallow nappe ductile shear zones in Jinshitan. The nappe tectonics have formed a series of structural features: fold, deformation, the small fold miniascape (Figure 3), inverted anticline (Figure 4). The inverted anticline turns into invented syncline, and forms the landscape of Holding-back Rivers & Overturning Seas (Figure 5). The recumbent fold (Figure 6) is one of the special structural forms in this area, and the axial plane of the fold is nearly horizontal, which is a common fold in the external system of nappe tectonic. There is a sea cliff up to 20 meters in the area, and a large buckle is lying on the cliff. Its kernel is the thick top buckle tightly composed of shales. The ala is uniform thick buckle composed of mudstone, and the flexural slip of the buckle is obvious with the intraformational fold and cleavage in typical development. And limited by stratification plane, the cleavages of the buckle are dense and parallel to each other, which fan out and skew with the stratification plane, being not only isophcnic but also equilong, and are dragged into the opposite S shape. The buckle with typical development, grand scale, complete exposure, and always favored by geologists at home and abroad, is the rare textbook for geological research and the "standard model" of recumbent buckle.
3.2.3 Typical sedimentary geological phenomenon: crack

The crack is also known as dry crack. This geological phenomenon is also distributed in other places such as the Wangwu mountain-Daimei mountain in China, but it is more typical and widely distributed in the area of Jinshitan. The "Crack Rock" in Jin-
shitan scenic area (Figure 7), a living specimen of the sedimentary environment, is the largest and most clear in fault plane structure sample of sedimentary rock found in the world. The stratification plane of rock is shaped like a turtle shell and the section like a honeycomb, and the crack of the rock is 2 to 3 centimeters wide, a few centimeters to a few hundred centimeters deep, cutting across the whole plane. The color of the crack filler and the stratification plane of the rock are different, forming the turtle pattern of color change. This well-developed crack is rare in the world. After visiting, the world-renowned geological scholar Professor Claude repeatedly said that the cracked rock of Jinshitan Park is one of the world's largest and most beautiful cracked rock, not only in China, but also in the world. The study on the internal structure of sedimentary rock, sedimentary environment and paleogeography of cracked rocks has certain scientific value and ornamental value.

3.2.4 Paleontological fossils - the treasure-house of fossils of trilobite

The trilobite (Figure 8), a marine arthropod that existed between 500 million and 600 million years ago and gradually became extinct. The remains of the trilobite are buried and petrified in the strata, becoming the fossils that are representative for the Cambrian period (500 million to 600 million years ago) and widely distributed in the shales of Cambrian. Trilobites are distributed in many areas of China, and their fossils are also found in the geopark of Yuntai Mountain. Compared with Yuntai Mountain, fossils of the trilobite of Jinshitan Park are widely distributed, with a large quantities and species, and the most of them are Bailiella, Blackwelderia, Calymene and so on. With the fossils of trilobite being seen everywhere, this area could be called the treasure-house of fossils of trilobite.

3.2.5 Sea-worn landform landscape

It is the bedrock coast of this park that the coastline is meandering and the ria coasts are spaced in distribution. Under the abrasion of the waves, a variety of sea-worn landforms are quite developed, for example, sea cliff, sea cave, marine stack, sea-worn arch bridge and so on. The oddly shaped marine abrasion rocks have appeared under the erosion of seawater, some like animals, some like portraits of various postures: Beasts landing, Full-wing Roc Flying(Figure 9), Dinosaur swallowing sea (Figure 10) and so on, which constitute an elegant geological gallery.

![Figure 8](image1.jpg)  **Figure 8**  Fossil of trilobite

![Figure 9](image2.jpg)  **Figure 9**  The landscape of Full-wing Roc Flying
4 The evaluation of the scientific and tourism value of the geopark

Geoheritage landscapes of the geopark are widely distributed, diverse, well preserved, with special scientific significance, rareness in nature, and aesthetic value of geological landscape resources, are the ideal places for scientific research, science popularization education, sightseeing and leisure vacation, as well as the very rare and precious wealth in China even all over the world.
4.1 Scientific value

4.1.1 Scientificity

There are a variety of sedimentary strata and geological structures that are of great scientific value to trace the geological history in the park, such as the relics of the genetic stratigraphic study of the Neoproterozoic sedimentary strata, fossil remains, TTG complex remains of Neoarchean, large horizontal ductile shear detachment structure relics between basement and caprock, small estuary mafic dikes of Paleoproterozoic, upright fold, inclined fold and recumbent fold remains of the sediment cover since the Neoproterozoic Erathem. These are of great significance for studying the geological evolution of the north margin of the North China plate.

4.1.2 Rarity

The most complete sedimentary strata of the Neoproterozoic in the north margin of the North China plate developed in Dalian, and the Desheng gneiss complex (TG rock series) of Neoarchaean is named in Dalian. Fossils of Neoproterozoic-Paleozoic are well preserved, numerous and diverse, and they have important scientific research value and geological significance in China.

4.1.3 Systematicness and integrity

Dalian is one of the well-developed Neoarchean TG complex regions in North China. The strata in the park can be described as "five generations living together", from the old to the new, developing with Neoarchean supracrustal rocks, Neoproterozoic Qingbaikou and Sinian system, Paleozoic Cambrian-Ordovician system, Permo-Carboniferous system, Mesozoic Jurassic-Cretaceous system, Cenozoic Tertiary and Quaternary system. The formation process and manifestation of the main geological structure remains are systematic and complete.

4.2 Aesthetic value

Some typical geological structures are also beautiful natural sceneries such as peaks, palisades, the caves of Pictographic stones and so on, which have high aesthetic value.
and ornamental value. The sea-worn landform, all sorts of strange reefs and stones, cliffs of Jinshtian Park and Hai Wang Jiu Dao park make up a beautiful scroll of long gallery given by nature, and all sorts of oddly shaped stones with very high ornamental value are elegant and amazing just like the sculpture of nature. So the scenic area with these geological structures is not only a exquisite resort, but also the base for popular science education. There are many wonderful views of sea-worn and marine landforms in the park because of the special tectonic settings and the coastal background. The Pictographic stones in the Dalian National Geopark have a long history, which are of the high value of scientific research and ornament.

4.3 The science education value

Dalian Coastal National Geopark is a large geological park with high scientific and aesthetic value. Geoheritage resources, ecological resources and cultural heritages scattered in the geopark make up a walking dictionary that records the geological evolution, the change of geographical environment and thousands of years of human cultural activities of the geopark. Based on the geopark, people can appreciate the beauty of natural landscape, and at the same time, they can understand the scientific connotation of natural landscape and learn the knowledge of earth science. This is of great significance and considerable value in popularizing science to meet the growing scientific and cultural needs and improve the national quality.

5 Suggestions on development and protection

5.1 Improving the management system and professional team

In order to strengthen management, Dalian Jinshitan Coastal Geopark Management Committee should be set up as the management authority of geopark. Under the direct leadership of the Dalian Government, the management committee is responsible for the development and construction, managerial functions of geopark, and the main task is to integrate resources, plan, coordinate and supervise the construction and protect the geoheritages. The professional team is the guarantee of the protection and development of geopark, and it should be provided the professionals of tourism management, geology and forestry, tour guide and other professionals. It is necessary to adjust the talent structure, so as to increase the professionals that understand the geoscience and environmental protection to participate in the management and administration of the geopark, and improve the management level through the adjustment of talent structural and training.

The geopark should organize a certain number of tour guides according to the need, and conduct the post training of the tour guides. After the examination, the tour guides would get the qualification certificates and go on duty with certificates. Park guides should be familiar with the tour routes and various scenic spots of the geopark, the locations and the landscape. Their training should be combined with the study of scientific knowledge and carried out by combining the field training and indoor professional knowledge training.

5.2 Doing the general survey of the geological resources and establishing the vendor library

Dalian Coastal National Geopark is rich in geological tourism resources, but at
present, in addition to some famous landscapes, many geological tourism resources have not been developed in depth and the quantity and quality of geological resources need to be clarified. A professional team should be organized to conduct a census of the geological resources, fill out the questionnaire in detail, and then include the information in the computer, establish a vendor library. To complete the investigation and evaluation of the types, distribution, quantity and grade of the geoheritages in the geopark, it is necessary to establish the archives of geoheritages, and investigate the real situation of the geoheritages in the geopark.

5.3 Strengthening the protection of the geoheritage landscapes

Most geoheritage landscapes belong to non-renewable resources, which may be destroyed if they are not properly protected and managed. For example, among the numerous geological landscapes in Jinshitan scenic area, the Jumping Fish stone (Figure 16) standing on the coast constitutes a wonderful sight. But because of improper protection from the wave erosion, it finally fell into the sea in 1994.

![Jumping fish](image)

Figure 18 Jumping fish

The management mechanism of geoheritage protection should be set up to detect and maintain the protected objects to prevent the ruins from being damaged and polluted. On the basis of distribution characteristics of the geoheritages of Dalian Coastal National Geopark, we should ensure to protect the geological and geomorphologic relic points and the typical stratotype section. The combination of “point” and “line” is used to protect the delimited conservation area of geopark. For the protection of geological and geomorphological relics, we should formulate regulations and rules for the management of local geoheritages, and use the necessary legal means to prevent the destruction of important resources.

5.4 Carrying out geological tourism, and designing reasonable routes of geological tourism

The geological tourism resources in Dalian Coastal National Geopark are abundant, not only peculiar but widely distributed. We should strengthen the development of geological resources as soon as possible, carry out the geological scientific tourism, design reasonable routes of geological tourism, and finally make the scenic area become the national geological practice base of universities and the national popular
science base of elementary and middle schools. We can develop multi-day tour products, create special tour routes, and combine the various geoheritage landscapes. ① The technology route of Jinshitan scenic area, mainly studying the geological formation profile, various fossils and the golden beach scenery, and analyzing the mystery of geology and paleontology 600 million years ago. ② The technology route of Cheng Shan Tou scenic area, mainly investigating the sea-worn landform and marine accumulation geomorphy, appreciating the wonders of the marine abrasion and understanding the reasons of its formation. ③ The technology route of Hai Wang Jiu Dao scenic area, mainly investigating the sea-worn landform, marine accumulation geomorphy and paleokarst landform, and analyzing the cause of its formation.

5.5 Establishing and improving the interpretation system and signage system of geopark

Popularizing scientific knowledge of geology is one of the main functions of geopark. In order to enhance tourists' understanding of the geological phenomena that they see, the best way is that after entering the park tourists could start with the geological museum and the tourist information center, in order to obtain the general situation of the geopark, and then listen to the interpretation of tour guide for sightseeing or read the explanation board of the scenic spot. To this end, we should establish a museum and the interpretation and signage system. Jinshitan Geopark should establish a geological museum as the interpretation center of geopark, fully display the geological knowledge through the typical specimens, scenes, models, and a variety of display languages such as sound, light and electricity, to show visitors the basic knowledge of the earth, life origin and evolution, the geoheritage landscapes, geological evolution and characteristics of geoheritage landscapes of Dalian Jinshitan Geopark. We should set the main monument in the park that reflect the scientific connotations of geoheritage scenic spots of the geopark, and set up the interpretation and signage system of geopark such as the explanation board of the scenic spot and scenery, public information signboard (direction mark, information label, management mark, publicity board, public service facilities mark) and so on.

5.6 Strictly controlling the environmental capacity of geopark, and protecting the precious geoheritage landscapes

The geoheritage landscapes of Dalian Coastal National Geopark are extremely valuable as non-renewable resources. The environmental capacity of the geopark must be strictly controlled in order to ensure the sustainable utilization of the resources. Environmental capacity refers to the sum of the maximum tolerance and tourism perception of the preservation of landscape resources and ecological environment of geopark. Reasonable environmental capacity is the scientific basis for reasonable organization of tourists and protection of geoheritages and landscape resources. After investigation and evaluation, the suitable environmental capacity of Jinshitan Park is 32154 people, and the annual suitable capacity is 5.8 million people.

5.7 Integrating the tourism resources in the scenic area, and doing well in comprehensive development of tourism

This area is a part of the Dalian Jinshitan National Tourist and Holiday Zone, the tri-
nity of national natural and cultural resource with the rare geoheritages, national park of China and forest park, forming the comprehensive environment of tourism that consist of popular science of geology, tourist attraction, special landscape, ecological environment. We should integrate the resources within the region to promote the tourism development. First of all, give full play to the advantages of beach tourism resources. Jinshitan is the largest natural lighting beach in Northeast China with the longest coastline, the best sand quality and the best water quality. And hold the Dalian International Beach Culture Festival, Dalian International Winter Swimming Festival, Beach volleyball World Match well. Secondly, we should improve the development of hot spring tourism resources in the region, improve the service of existing hot springs (Dalian Tang Dynasty Hot Spring Hotel, Dalian Tangjingze onsen Hotel), and highlight the characteristics to attract tourists, balance the seasonal tourism and improve the tourism efficiency. Third, develop maritime tourism projects and make full use of favorable coastline resources, provide not only a bathing place and the land of beach sports, but also a place of water sports like surfing, skateboarding, rowing, sailing and so on. Fourth, combine the movement (ocean theme leisure, entertainment) and the motionlessness (vacation, residence), to develop the tourism products with a combination of sport and leisure. Finally, combine the natural landscape and cultural landscape, integrate the cultural tourism such as Dalian Discoveryland Theme Park, Dalian Jinshi Wax Image Hall with geological tourism products, and introduce the tourism products and routes of combination of the natural landscape and cultural landscape.

6 Conclusions

Jinshitan scenic area is an important part of Dalian Coastal National Geopark, which concentrates the geological evolution and the evolution of the earth during the Sinian period 600 million to 300 million years ago. There are many typical geoheritages and strata with representative significance in China, which are well preserved, with special scientific significance, rare resource attributes, and high tourism value. We should deeply excavate the particularity and uniqueness of the geoheritages in Jinshitan scenic area, strengthen the protection of geoheritages, and make the tourism resources in this scenic area sustainable development.

References