



Korean Cretaceous Dinosaur Coast: Preservation and Monitoring Plans

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Abstract: Dinosaur trackways, skeletons of dinosaur, pterosaurs, crocodylian skulls, fishes, and turtles have discovered from the Cretaceous beds of Korea. Southern coast of the Korean Peninsula brought the world-renowned sites for dinosaur, pterosaur and bird tracks. Korean dinosaur trackways provide information of Asian dinosaurs that explain different types of movement and behavior. The smallest sauropod trackway along an adult trackway was found in a site of Goseong. The ornithopods trackways with sauropods in many localities indicate unique paleoecology for the Cretaceous fauna. A famous dinosaur trackway site in Haenam County also produced the world's largest pterosaur tracks. Most of the dinosaur tracks have been studied and recognized by Korean paleontologists since 1982. After the first discovery of dinosaur eggshell fragments in 1972 from the Hasandong Formation in the Gyeongsang Province, more than 30 dinosaur track localities have been reported from Cretaceous non-marine deposits. The quality of the dinosaur footprint preservation is excellent and most sites provide a good model of field study and hands-on experience for science education. The world scientific community regards Korean Cretaceous Dinosaur Coast as one of the most important sites in the world to study Cretaceous dinosaurs. The Natural Heritage Center has investigated and researched those dinosaur sites of the National Monuments since 2007. A Data Sheet System for fossil monitoring was invented and initial documentation was fulfilled by collecting site environment factors with biodeterioration stage. The Data Sheet System also includes damage factors by weathering and biological colonization.

Key words: Dinosaur, Footprint, Natural Heritage Center, Pterosaur, Fossil

Introduction

Korean paleontologists have discovered footprints and bones of dinosaurs, pterosaur remains, crocodylian skulls, skeletons of fishes, and partial skeletons of turtles from the Cretaceous formations after the discovery of dinosaur eggshell fragments from the Hasandong Formation in the Gyeongsang Province in 1972. The scientific value on the Korean Cretaceous localities already have appreciated and many scientific articles published by domestic and international scholars. Many experts on Cretaceous ichnology and paleontology have invited at several International Dinosaur Symposiums (1997, 2000, 2006, and 2007) and presented results of a comprehensive study on the major Korean dinosaur sites including Goseong and Haenam.

Cultural Heritage Administration of Korean Government decided to apply for a UNESCO World Heritage in 1999 by the importance and outstanding universal value of the Korean Cretaceous dinosaur tracks. In 2000, Korean Cretaceous Dinosaur Coast was listed as a candidate for

World Heritage Inscription. A preparation committee prepared a comprehensive management plan to formulate and implement management strategies that conform to the principles for conservation and management of the dinosaur tracksites. The application materials with management plans were submitted to the UNESCO at the end of January, 2008.

Academic Value of the Major Dinosaur Track Sites

Goseong dinosaur and bird tracksite (Natural Monument No. 411)

The Deokmyeong-ri of the Goseong area is one of the largest dinosaur track sites from a single formation in the world. The first dinosaur footprint of Korea was found in 1982 at the Deokmyeong-ri site and the discovery is the first report by professor S. Y. Yang as a scientific publication in Journal of the Geological Society of Korea. The ornithopod trackways are the most dominant trace fossil and numerous bird tracks were also found in the same site. The Goseong site is one of the highest concentrations of track-bearing levels recorded in the world (Lockley, 2007).

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Fig. 1. A sauropod trackway at the Goseong Deokmyeong-ri site.



Fig. 2. A well-preserved ornithopod track at the Goseong Deokmyeong-ri site.

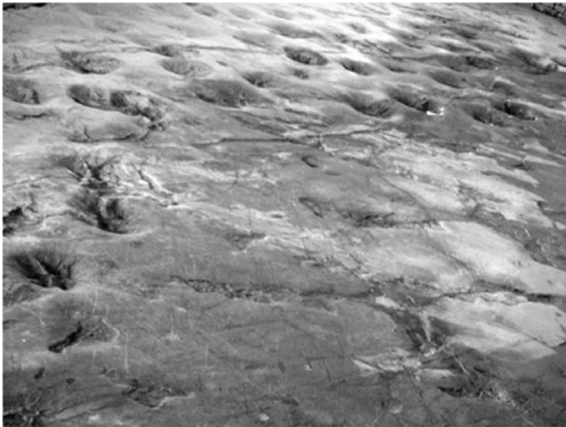


Fig. 3. dinosaur trackways at the Haenam Uhangri dinosaur site.

The site includes ornithopod trackways which is in parallel for its direction. The trackways also show excellent preservation and are among the best example in the world which suggests its gregarious behavior (Yang, 2007).



Fig. 4. A dinosaur trackway at the Yeosu dinosaur tracksite.



Fig. 5. Ornithopod footprints of the Yeosu dinosaur tracksite.

Yeosu dinosaur tracksite (Natural Monument No. 434)

The Yeosu dinosaur tracksite has produced more than 3,500 dinosaur footprints including more than 80 trackways in the islands of Chudo, Sado, Nangdo, Mokdo, and Jeokgeumdo (Huh et al., 2001). One of the best known trackways from the site is a long ornithopod trackway which has 85 meter long. Several levels with well-preserved ornithopod and theropod trackways were discovered from the Nangdo. Sado yields theropod footprints, ornithopod trackways, and bird footprints in a same horizon.

Boseong dinosaur egg site (Natural Monument No. 418)

The Boseong egg site is unique in that visitors can access to dinosaur nesting areas. The site also yields the most

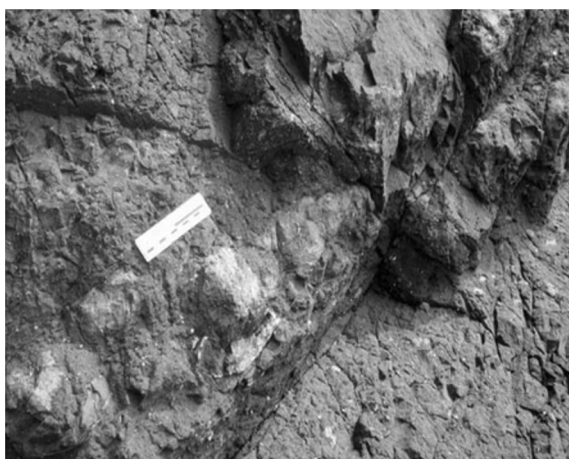


Fig. 6. Dinosaur eggs from the Boseong dinosaur egg site.



Fig. 7. A theropod footprint at the Hwasun dinosaur site.

completed skeleton of plant eating dinosaur. The articulated dinosaur skeleton is the best specimen and may designate a new species of hypsilophodontid ornithomimid dinosaur which could be from the youngest formation.

The complete dinosaur eggs might belong to sauropods or ornithomimids in the basis of their morphology and thickness. The site has potential to produce more nesting sites and vertebrate skeletons including dinosaurs and turtles.

Hwasun dinosaur tracksite (Natural Monument Candidate)

The Hwasun site is unique because of its number of well-preserved theropod dinosaur footprints and variation in theropod footprint morphology. The three kinds of theropod morphotypes can be identified up to now. There is a titanosaurid trackway which has a narrow gauge. The site yields more than 1,000 dinosaur footprints including at least 60 trackways in five levels. The Hwasun is one of the youngest horizon of the Late Cretaceous.



Fig. 8. Goseong Dinosaur Museum for the public education.

Korean Dinosaur Museums for Natural History Education

Goseong Dinosaur Museum

The Goseong Dinosaur Museum is the first of its kind in Korea. It is located within perimeter of the Sangjokam County Park in the Goseong county. It has one underground floor and three floors above the ground in an aggregate area of 1,324 m². It has more than 100 fossil specimens on exhibit, including dinosaur and pterosaur skeletons. In the museum square, the tallest dinosaur tower in Korea (24 m high) stands with an observation platform on its top floor. The Goseong Dinosaur Museum has emerged as one of the most celebrated sights sought by tourists.

Two of Asian dinosaurs, *Monolophosaurus* and *Klamelisaurus*, are fighting in the underground floor. The dinosaurs lived during the Jurassic period and collected from the Wucaiwai layer in China. Three pterosaurs (*Dsungaripterus*, *Quetzalcoatlus*, and *Pteranodon*) are hanging on the ceiling at the main hall. The second exhibition introduces visitors dinosaurs' footprints in Goseong county. The visitors can study the differences among the various dinosaurs' footprints from local areas. There are many hands-on interactive activities for children in the Dinoland. Children can learn about dinosaur through various kinds of activities; i.e. how fast dinosaur is, how tall dinosaur is, and so on.

Haenam Uhangri Dinosaur Museum

The Haenam Uhangri Dinosaur Museum exhibits replicas of dinosaur skeletons coming from Mesozoic and sites around the world. The Uhangri Hall explains the excavation process of Uhangri dinosaur footprints by stages and facts of paleoenvironment in the Late Cretaceous period. The museum displays one of the most completed dinosaur specimen, *Allosaurus* which was collected from USA (Fig. 9).

The Haenam Uhangri Dinosaur Museum, which is opened on April 27th of 2007, was built right next to the



Fig. 9. Dinosaur skeletons of the Goseong Dinosaur Museum.



Fig. 10. *Allosaurus* skeleton at the Haenam Uhangri Dinosaur Museum.



Fig. 11. Dinosaur skeletons at the Haenam Uhangri Dinosaur Museum.

Haenam dinosaur, pterosaur, and bird track site (Natural Monument No. 394). Three roofed buildings were constructed for protection and conservation. The Haenam Uhangri Dinosaur Museum attracts many students and



Fig. 12. Field works for the Data Sheet System for the tracksite monitoring.

tourists with fossil collections and hands-on exhibitions. It also provides information and knowledge with local dinosaur trackways and geological phenomenon.

Discussion

Korea is famous for Cretaceous trackways of dinosaurs and pterosaurs. The many sites have produced new species bird tracks. The major dinosaur sites show excellent conditions on preservation and indicate unique aspect to compare Korean dinosaurs with Chinese and Japanese dinosaurs. Korean Cretaceous Dinosaur Coast provides data of Cretaceous paleoecology from various analysis and fieldworks. Cultural Heritage Administration of Korean Government designates most important dinosaur track sites as Natural Monuments for conservation and comprehensive survey with monitoring with a long range plans. Natural Heritage Center of Korea dedicated to investigating, studying, and educating people on natural heritage as well as to sharing the values and importance of natural heritage with general public. In the April 12th of 2007, the Natural Heritage Center opened its exhibition hall to display results of its studies on Korea's precious natural heritage in a way that is easy and interesting for the visitors to explore.

Korean dinosaur trackways including all National Monuments to be protected and managed properly for general public and scientists forever. With a comprehensive preservation plans, Natural Heritage Center and Cultural Heritage Administration promote constant monitoring and educate local peoples to watch any environmental change. Local government and scientific advisory committee will promote efficient management by coordinating between the non-government organizations and local communities. The Natural Heritage Center has investigated and collected environmental factors for the dinosaur trackways since 2007. All information will be analysed and synthesized for the Data Sheet System for fossil site monitoring (Fig. 12). The Data Sheet System includes possible damage factors by weathering, biological colonization, and other

contaminations. With the newly invented Data Sheet System for the fossil site monitoring, major dinosaur track sites will be studied under the long term project and preserved for future generations.

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