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National Research Institute of Cultural Heritage

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FEATURED COLUMN:
Crossing Frontiers Between Cultural Heritage and Natural Science

2022

National Research Institute of Cultural Heritage of Korea

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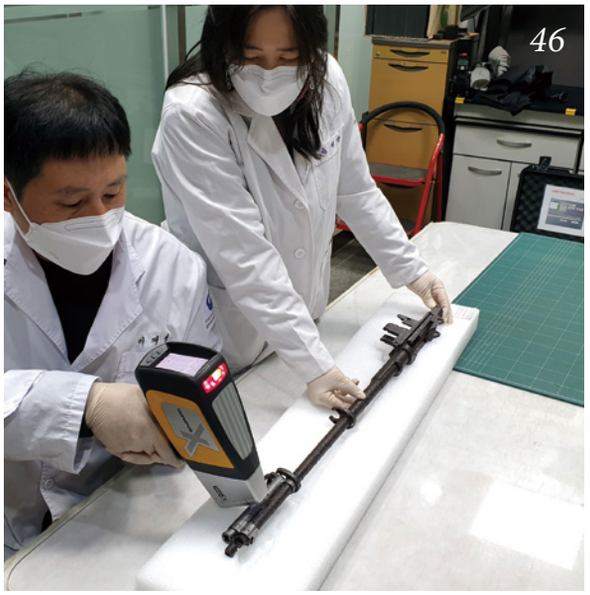

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Director's Message

Greetings from Seoul,

I am truly delighted to release the fourth issue of the "NRICH," an English newsletter of the National Research Institute of Cultural Heritage. As we publish more issues, I am glad that the magazine is gaining reputation as a good guide to understanding Korea's history and culture.

The fourth issue is themed "Crossing Frontiers Between Cultural Heritage and Natural Science." Researching an object only by its morphological or materials characteristics yields limited information only. There are more inside the invisible inside of cultural heritage and many scientific technologies are used to answer questions such as when, why and how the cultural heritage was created. In today's world, it has become very common to apply X-ray, 3D scanning and computed tomography (CT) to cultural heritage.

Estimating the relative age of a relic by tracing the evolutionary development process based on the external shape or structure of an artifact is now very elementary. Devised by Willard Libby in 1949, the radiocarbon dating method, which measures the age of organic materials through radioactive decay, is now the most commonly used dating method and has been so generally used that it feels almost classical. Introduction of the accelerator mass spectrometry (AMS) has upgraded the radiocarbon dating method, taking it to the next level. Various scientific dating methods including luminescence dating, dendrochronology and archaeomagnetic dating are used to trace the age of archaeological materials. Human bones from thousands of years ago is more than a sample to reveal physical characteristics of human, but more widely used to unravel the genetic information, paleodiet and disease by DNA and isotopes extracted from bones and other human remains. In addition, geographical Information system (GIS) is expanding the understanding mutual context of surrounding environment and broadening the scope of cultural heritage research.

Currently in Korea, numerous natural scientists are conducting multidisciplinary research with cultural heritage experts including archaeologists, art historians and ancient architects. The results of their joint research are constantly pouring out, not only from cooperation in the fields of excavation or investigation of cultural heritage, but also from laboratories and forums. All of this was made possible through the synergy between cultural heritage and natural science.

I look forward to the day when everyone who loves cultural heritage all over the world can escape the gloomy veil of COVID-19 soon, stand shoulder to shoulder and explore cultural heritage sites together. Until then, I hope this "NRICH" newsletter would be your companion, providing some comfort. I send my deepest gratitude to all the readers.

Director General of National Research Institute of Cultural Heritage

Dr. JI Byongmok

NRICH History

Cultural heritage that have formed naturally or artificially over many years are valuable properties not only for the people of their country of origin but for all humankind due to their historic, artistic, and academic value, and their natural beauty in the case of landscapes. As such, it is every country's duty to survey and study them and to preserve them for future generations.

The National Research Institute of Cultural Heritage has been striving to reveal and spread the value of our culture and history through research for the past 50 years and has become the only research institute in Korea that is in charge of comprehensive research on cultural heritage. It is our responsibility to enhance the value of the country's culture through creating knowledge and promoting cultural heritage and we aim to become a world-class cultural heritage research institution.

1969. 11.

The National Research Institute of Cultural Heritage established (In Seoul)

1970's

1973
Excavation of Cheonmachong Tomb (World Heritage)

1975
Excavation of Hwangnam Grand Chong Tomb (World Heritage)

1976
Excavation of Donggung Palace and Wolji Pond, Gyeongju (Anapji, Historic Site No. 18)

1973
Started research in the field of artistic cultural heritage (*First target: Buddhist bells)

1975
Started research on conservation science for cultural heritage

1980's

1980
Excavation of Mireuksa Temple site, Iksan

1983
Excavation of Hwangnyongsa Temple site, Gyeongju

1984
Survey of all the Buddhist painting in Korean temples

1990's

1990
Expanded excavation in ancient capitals (Gyeongju, Buyeo, etc.) through opening regional offices

1999
Conducted repair and restoration on Iksan Mireuksa Temple stone pagoda

2000's

2004
National Research Institute of Cultural Heritage relocated (to Daejeon)

2005
Implemented cultural heritage restoration technology and materials research

2006
Expanded research to natural heritage

2010's

2005~2019
Established regional research offices and one conservation center

2017
Implemented safety and disaster prevention of cultural heritage in light of climate change and potential disaster risks

NRICH Organization

Director General

9 Divisions

- Administrative Division
- Planning and Coordination Division
- Research Division of Archaeology
- Research Division of Artistic Heritage
- Research Division of Architectural Heritage
- Conservation Science Division
- Restoration Technology Division
- Natural Heritage Division
- Safety and Disaster Prevention Division

7 Regional Offices

- **Gyeongju** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Buyeo** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Gaya** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Naju** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Jungwon** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Ganghwa** National **R**esearch **I**nstitute of **C**ultural **H**eritage
- **Wanju** National **R**esearch **I**nstitute of **C**ultural **H**eritage

1 Center

- Cultural Heritage Conservation Science Center

Featured Column

1. Scientific Non-Destructive Testing on Hahoe Masks and Byeongsan Masks of Andong, National Treasure
2. Large-Scale Buddhist Paintings Bloom Through Scientific Analysis
3. Tracing Horse Culture, Driving Force Behind Cultural Exchanges in Ancient Eurasia
4. Astronomical Science of Joseon Dynasty
5. Landscape Research of Royal Palaces of Silla

Scientific Non-Destructive Testing on Hahoe Masks and Byeongsan Masks of Andong, National Treasure

Cultural Heritage Conservation Science Center
SONG Jiae

1. Introduction to Hahoe Masks and Byeongsan Masks of Andong, National Treasure

Hahoe Masks and Byeongsan Masks of Andong, designated as National Treasure of Korea, are wooden masks handed down in Hahoe and Byeongsan Villages in Andong. Dating back to the Koryeo period, the masks are the oldest existing stage play masks in Korea and recognized around the world for their exquisite production technique and detailed expressions.

Korean masks are typically made of paper-mache or gourd and are burnt after the mask play, Talnori performance. However, Hahoe Masks and Byeongsan Masks are rare examples of wooden masks and each village preserved their masks that were used for Byeolsingut (a village ritual held to pray for peace of the village and good crops) on the first full moon of the year, which falls on January 15 of the lunar calendar.

A total of 13 pieces of Masks are designated as National Treasure—11 Hahoe Masks and 2 Byeongsan Masks. Some masks among Hahoe Masks such as the Nobleman have chins carved on a separate piece of wood and attached to the face with a string, so they create a livelier look as if the character is moving their mouth when speaking. On the other hand, Byeongsan Masks are larger and heavier without chins.

❶ Hahoe Masks and Byeongsan Masks (National Treasure) of Andong

2. Non-Destructive Testing Through Science and Technology

Those Masks did not go through detailed scientific surveys or conservation treatment after being designated as National Treasure. A regular checkup on state-designated cultural property in 2020 revealed that some of the masks were in need of conservation treatment and the Cultural Heritage Conservation Science Center has been carrying out the project since 2021.

The Center is conducting the current status of the masks and the condition survey before the conservation treatment to collect information on mask making techniques. The condition survey is divided into two parts—a survey on the status of the artifact including taking photographs, taking measurements of

dimensions and weight, mapping the deterioration, and then a precise documentation through non-destructive analysis. The precise documentation consists of examination of internal structure, analysis of material, observation of invisible underdrawings and traces of repair and 3D Scanning.

The X-ray testing and Computed Tomography (CT) identified that woods were cut in axial direction to carve the mask (Figure 3) and colored on a foundational layer. For the Gaksi Mask, metallic materials were used for the joint (Figure 4) and repaired parts through UV survey were found.

Pigment analysis using portable XRF (X-ray fluorescence) and XRD (X-ray diffraction) identified that the vermillion color used for the Yangban Mask is from Lead Red (Pb_3O_4), while the white color used for the Gaksi and Bune Masks is from Lead White ($2PbCO_3 \cdot Pb(OH)_2$), and Cinnabar (HgS) is confirmed on the red rouge on cheeks and forehead.

Computed Radiography (CR)

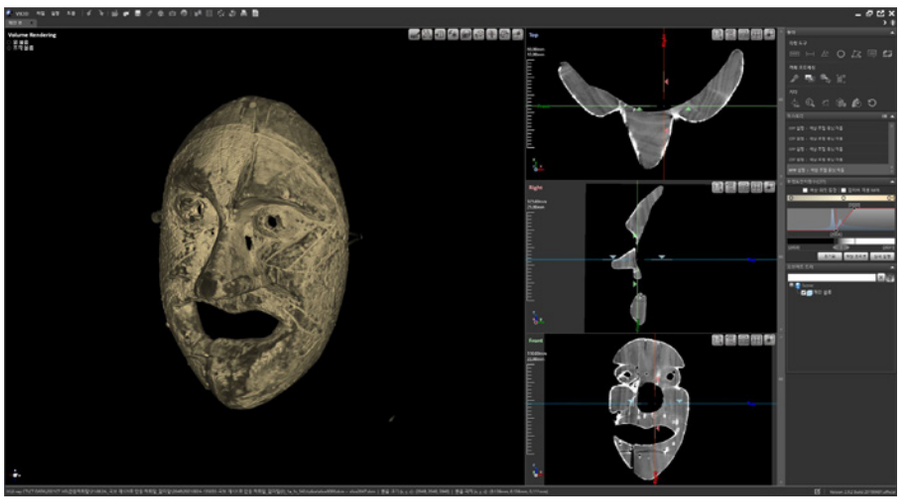
Computed Tomography (CT)

Infrared inspection

Ultraviolet inspection

3D scanning

❷ Precise documentation through non-destructive analysis of the Yangban Mask

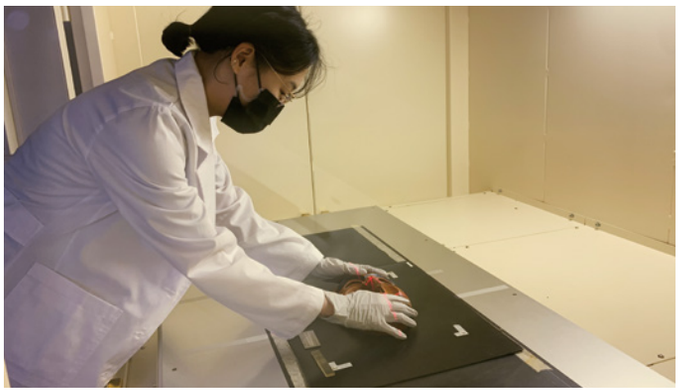


❸ Computed Tomography (CT) of the Halmi Mask

❹ Computed Radiography (CR) of the Gaksi Mask

❺ Ultraviolet inspection
(Conservation Science Division of NRICH)

❻ Ultraviolet inspection of the Gaksi Mask



❼ Computed Radiography (CR)

❽ X-ray diffraction (XRD) pigment analysis
(Conservation Science Division of NRICH)

3D scanning provides precise deterioration map and measurement data of those Masks. Studies will also be conducted to find ways of merging the digital data such as X-ray CT and 3D scanning results.

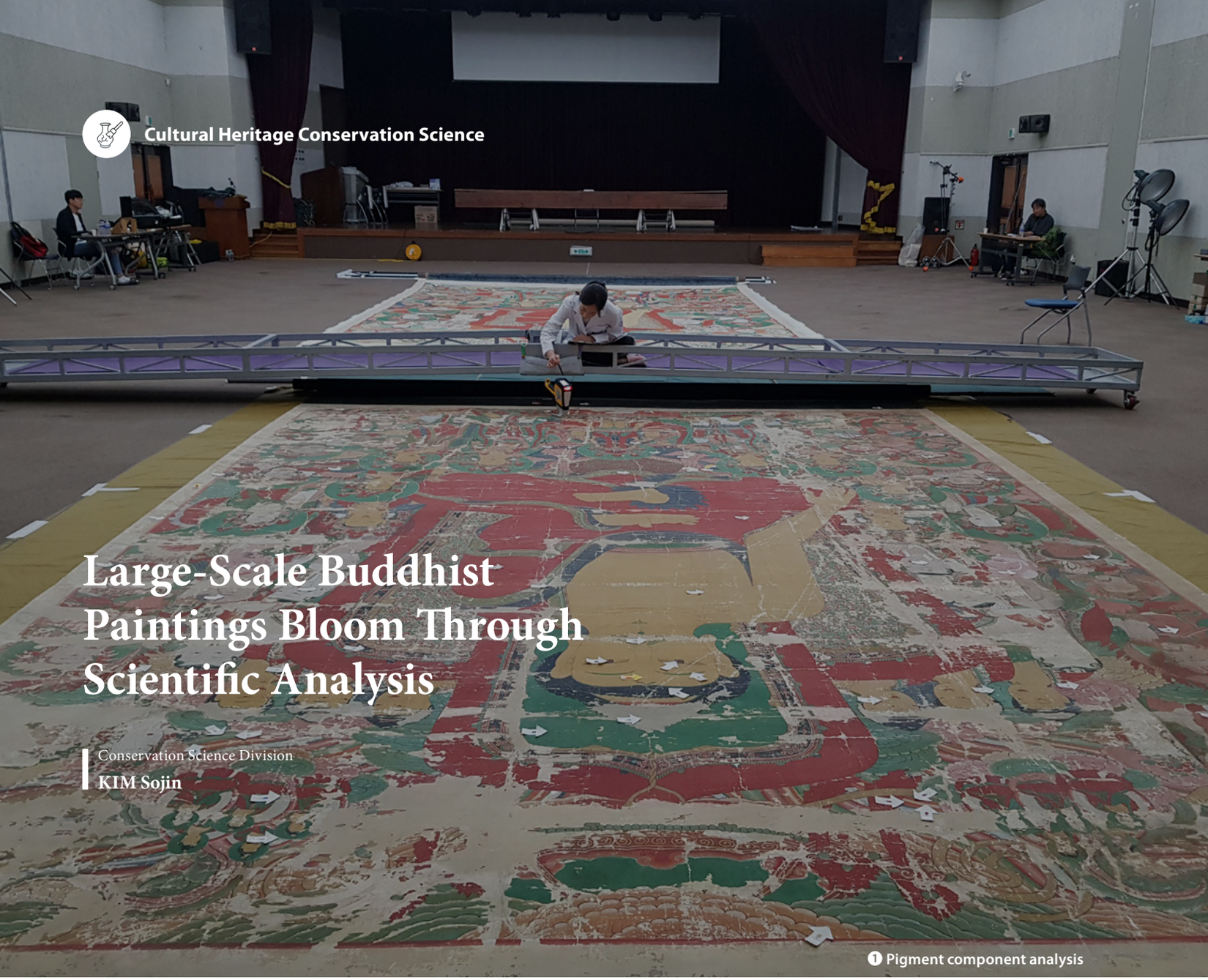
As such, the range of non-destructive investigation using scientific equipment has increased the scope of the condition survey conducted prior to the conservation treatment. After conservation treatment measures are devised based on the collected data, the actual conservation treatment on the Hahoe Masks and Byeongsan Masks of Andong will begin in March 2022 and is expected to be completed by December 2022.

❾ Imaging for 3D scanning

❿ 3D scanning of the Juji (male and female) Masks

Large-Scale Buddhist Paintings Bloom Through Scientific Analysis

Conservation Science Division
KIM Sojin



❶ Pigment component analysis

Large-scale Buddhist paintings were produced for grand outdoor Buddhist ceremonies from the 17th century onwards as Buddhism in Joseon Dynasty (1392-1910) set much importance on ceremonies. Joseon-era large-scale Buddhist paintings were produced from the 17th century until 1945, and approximately 120 pieces still remain. Currently the oldest existing large-scale Buddhist painting in Korea is the "Hanging Painting of Sakyamuni Buddha" at the Jungnimsa Temple in Naju, South Jeolla Province, created in 1622. Most large-scale Buddhist paintings measure 10 meters long and six to seven meters wide. These large-scale paintings can be found in Korea as well as China, Japan, Tibet and Mongolia, but the way of hanging differs by country. Joseon-era large Buddhist paintings are typically hung in front of Daeungjeon Hall, the main building of a temple, while in Tibet, the Buddhist paintings are hung over natural features such as hills or plains. Similar paintings in Japan differ in their iconography, as well as the location where the paintings are hung, as well as the ceremonies that are conducted. As seen in these examples, large Buddhist paintings are important cultural heritage to identify the universality and particularity of Buddhist culture in East Asia.

Large-scale Buddhist paintings are hard to manage and preserve as they are difficult to move due to their size and weight. The Conservation Science Division and the Cultural Heritage Conservation Science Center of the National Research Institute of Cultural Heritage conducted a comprehensive research to identify the status of large Buddhist paintings to prevent factors that could potentially damage the paintings as well as provide detailed information on them. The Institute is carrying out a 10-year scientific research project on 68 large-scale Buddhist paintings, which are difficult to move or investigate and as of 2021, the survey and investigation on 47 paintings have been

❷ Conducting infrared photography

❸ Conducting microscopic examination

completed. Six additional Buddhist paintings are scheduled to be inspected this year.

The Cultural Heritage Conservation Science Center conducts infrared reflectography to look through the surface paint to reveal baseline sketch and documents the current status of the painting by recording surface contaminations and missing parts. Infrared reflectography has discovered hidden paintings underneath the painting layer and pigment names marked for easier coloring. Documenting the current status of a Buddhist painting is essential in deciding whether it needs conservation treatment or not.

The Conservation Science Division examines and analyzes large-scale Buddhist paintings closely with various equipment. Through the process, we are able to collect diverse information about cultural heritage. What material was used to make the screen on which the Buddhist painting was drawn? What coloring materials and pigments were used for the Buddhist painting? To answer these questions, we employ non-destructive testing equipment and take a small amount of sample to investigate again at the lab for a more credible result. The research and analysis largely focuses on two areas, on the fabric and pigments.

The material and the weave of the fabric used are examined under a microscope. Hemp cloth, silk and paper were the most common material and many paintings connected multiple strips of fabric to cover the large screen.

The Buddha is drawn on the large fabric and then colored to bring the painting into life. For coloring, a variety of pigments and dyes were combined to depict various colors. The researchers first examine the shape and size of the pigment particles and the coloration status through a portable microscope and analyze the ingredients with portable X-ray fluorescence spectrometers. Spectrophotometer is used to measure the color difference in order to make a clear distinction between single or mixed colors of pigment. If pigment particles are not identified, it means that dyes have been used for coloring. Dyes are analyzed through UV-VIS spectrometer and Raman spectroscopy.

The analysis results revealed the following components for colors red, white, black, green, blue and yellow. Red pigments used in large-scale Buddhist paintings include Cinnabar, Minium and Seokganju where these have been used independently or mixed. For white color, Lead White, White Clay, Talc, Oyster Shell White, Mica and Titanium White were used. It is difficult to discern the ingredients for black color through non-destructive inspection and a fairly large amount of sample is required for precision analysis. Common ingredients for black are *Meok* (ink stick) or Indigo dye. The most popular ingredient for green color of Buddhist painting is Seokrok, a type of green pigment

❹ **Conducting scientific analysis**

❺ Conducting dye analysis

coming from rocks, which is used alone or mixed with Lead White. Ultramarine Blue, Azurite, Smalt, Prussian blue and Indigo dye were used for blue color, often mixed with each other to portray a wide range of blue colors from light blue to indigo. Azurite was the most used blue pigment, while the Annals of the Joseon Dynasty documents imported Smalt as the earliest among the cobalt pigments. For yellow, Gamboge dye and Orpiment, arsenic sulfide mineral pigment were used.

Other scientific investigations conducted on large-scale Buddhist paintings include ultraviolet irradiation for checking damaged sections that were repaired in the past, analyzing the species of the wooden box used to store the painting, microorganism study of both the painting and its storage area to provide preliminary data for conservation and management. Through these efforts, we rediscover values hidden in these large Buddhist paintings and prepare to pass down these paintings safely to future generations.

❻ Microorganism investigation on the surface of a large-scale Buddhist painting

Tracing Horse Culture, Driving Force Behind Cultural Exchanges in Ancient Eurasia

Research Division of Archaeology
NAM Sangwon

❶ Horses buried in the tombs of the Pazyryk culture, Mongolia

We live in a small world now. It is not an exaggeration to say the whole world is in the same cultural circle as people across the globe continuously communicate and influence each other. At this very moment, just with a mobile phone in our hand, we can watch a concert of BTS in the United States and cheer with a friend living on the other side of the earth through the internet.

Such moment is nothing new these days, but only some 200 years ago, before the invention of the steam engine in the 19th century, human's fastest means of communication and transportation was horse. According to archaeological theories, humans had formed intimate relationships with horses some 5,500 years ago. The materials excavated from the Botai culture in northern Kazakhstan revealed a number of horse bones including worn down jawbones showing signs of bridling, and pottery pieces containing traces of horse milk. Researchers judge that these horses were domesticated, signaling the beginning of nomadic pastoralism.

Without domestication of horses, development of networks in human societies such as conquest, trade, propagation and communication would have been very slow. We probably couldn't have even dreamed of watching the BTS from the other side of the world today. Horse holds a special place in the history of human, more than just providing foodstuff and labor.

A notable historical anecdote related to horse dates back to the 4th century BCE. A horse dealer came to King Philip II of Macedonia and offered him a fierce horse with black coat and a massive head named "Bucephalus." The name Bucephalus refers to pig-headed, which could be an insulting name for a horse. No one could tame the horse, but the king's 12-year-old son succeeded in subduing the horse. King Philip II was impressed by this and told his son, "Look out for a large kingdom equal to and worthy of yourself, as Macedonia is too small for you." His son, Alexander the Great who fought on Bucephalus, created a vast empire that stretched from Greece to part of India, blossoming the Hellenistic culture. We have to meditate upon the implications of this story—the probability between domestication of horse and expansion of territory. If it had not been for the horse, would it have been possible for Alexander the Great to conquer such large territories? How did the Mongol Empire establish the largest land empire in history less than 100 years? The physical driving force behind those tales can all be found in horses.

The National Research Institute of Cultural Heritage (NRICH) is conducting interdisciplinary research with other Eurasian countries with nomadic culture, including Mongolia, Kazakhstan and Russia, to take a deeper look into the beginning, spreading and settling of the equestrian culture. Three divisions of the NRICH, the Archaeology, the Conservation Science and the Cultural Heritage Conservation Science Center, are jointly participating in the project.

In relation to this project, I had taken part in the excavation of a tomb of the Pazyryk culture[1] in the Altai Mountains in Mongolia. The words Altai and Pazyryk may be familiar to those who are interested in the world history. Altai is derived from the word "Altan," which means gold in Turkic and Mongolic, so it literally means the golden mountain. In the Greek myth, griffin, a mythical animal with the body of a lion with the head and wings of an eagle, guards the gold of the Altai Mountains. The Pazyryk culture originated from this region. In the Botai culture, it is difficult to estimate how much horses were used in life, but in the Pazyryk culture, horses were buried in their owner's tombs as sacrifices. The horse's skull had a hole, presumed to be hit by a pointed instrument. The horses were furnished with iron harnesses including bits and saddles, suggesting that the Pazyryk people rode horses. Intact skeletons of horses provide zoological characteristics of horses then.

Meanwhile, Korean and Kazakhstani researchers together have excavated and surveyed mounded tombs of the Saka people[2],

❷ Iron horse bit excavated from the Pazyryk burial mound No. 9

❸ A hole found in the skull of a horse buried in the Pazyryk tomb in Mongolia

1) An early Scytho-Siberian Iron Age archaeological culture found in the Altay Mountains, dating back to the 5th-3rd centuries BCE. Its characteristics include tomb mounds covered with boulders, horse gears, bronze knife and animal-shaped ornaments.

2) A group of nomadic Iranian peoples who historically inhabited from the Black Sea region in eastern Europe to Xinjiang, China and covered the largest territory among the ancient nomadic cultures of the same period. Documented as Scythians in ancient Greek texts, Saka in the Achaemenid-era old Persian inscriptions and Sai in ancient Chinese records. They are known for iron weaponry, the first horse gears to ride horses and fancy animal ornaments.

❹ Investigating horse harnesses at the National Museum of Kazakhstan

who lived in around the same time as the Pazyryk people, in Kazakhstan. The burial grounds, located in the plains of the Zhetysu Region, southeastern Kazakhstan, dates back to the 5th to 3th century BCE. Unlike the tomb of the Pazyryk culture which buried the whole body of horse as sacrifices, parts such as leg bone, pelvis and rib are found in the Saka tombs, which are estimated to be food offered the tomb occupant. The Saka people's horse-riding culture can be seen through many archaeological remains collected in the National Museum of the Republic of Kazakhstan in Nur-Sultan.

Culture develops from the process of humans adapting to their surrounding environment. However, speaking of arising of the horse-riding culture, not every horse culture probably had horses in the beginning. Some cultures pursued sedentary farming, while others were nomadic, moving from one area to another. It has been suggested that horse culture appeared later in the sedentary farmers than in the nomads. Riding a horse has so many advantages in human life, so the horse culture must have spread in any way. This is just like how people around the world all use automobiles and smart phones regardless of its inventors.

Then how did this horse-riding skills have diffused among different cultural regions? To answer this question, the NRICH is looking into this with various scientific technologies.

First, we study horse equipment through archeological methods. Harness is a device used on horses to connect human and horse for domestication. It is classified into control gear, safety gear, armor and ornament, depending on the purpose. Control gear was the first to be invented as it is essential to control the horse. The key control device is bits, which is a metal or organic structure inserted into a horse's mouth and places pressure in the mouth, causing pain to the horse. In the aforementioned sentences, a horse tack is described as a connecting device between human and horse, but from the perspective of a horse, it could be just an instrument of torture. The material, shape, production technique of the bits differ by time and region, so researching bits provides hints on the group of people who used the bits on horses and their lineage. Most bits existing are in metal and discovered as a lump of rusty iron, corroded underground for a long time. The rusty piece cannot be identified and compared, so it is important to restore it to the original state.

The research is primarily conducted on ancient horse harnesses unearthed from the Korean Peninsula. Korea is located at the farthest eastern end of the Eurasian continent, which is the final destination of archaeological cultures from a geopolitical perspective, which makes the studies more interesting.

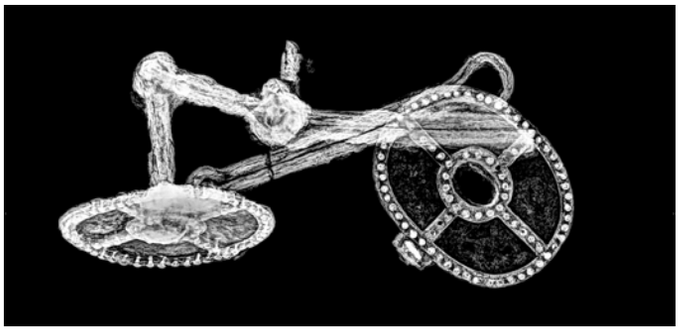
Restoration of an artifact begins with high-precision 3D scanning. 3D scanning guarantees exact numbers of the size of each part of the horse gears and the accumulation of such data is expected to allow analysis on production site and distribution

❺ 3D model of a horse wearing restored horse tacks

❻ 3D scanning investigation of an artifact

network through statistics. 3D data can restore the static artifact, which has been hardened to prevent further corrosion, to its original state and can be equipped on a horse via virtual simulation. Securing such data can be an invaluable resource in documenting and managing the artifact.

To figure out the origin and history of the horse gears, the artifact's production technique, as well as its shape, is an important criterion for classification. As mentioned earlier, corroded harnesses have many parts invisible to the naked eye—How many strands of wire are twisted together to form a bit; Was the bit made by twisting or not; Which part was connected to complete the piece. Until now, such production techniques were mostly explained based on the observer's subjective judgment, which is not the objective fact.



❼ Computed radiography of a horse bit excavated in Korea

Scientific methods can complement the result. Computed Radiography (CR) is one of the ways. In the past, when a doctor in a television drama shows an X-ray photo to his patient, diagnosing the patient with end-stage liver cancer, the X-ray image was often blurry and difficult to tell the liver and the tumor apart, making it hard for the viewers to sympathize with. Previously, X-ray imaging used to investigate cultural heritage was also in a very low quality, thus difficult to observe the metal good in blurry images. However, digital radiography (CR) provides more detailed digital images as the object is radiographed on an imaging plate with photostimulable phosphor instead of analog X-ray film. Combined with 3D scanning, CR can provide more precise information on the artifact and the details can be critical in finding the horse gear's history and regionality.

In studying the ancient equestrian culture of Eurasia, biological study of horse is as important as scientific analysis of human-made objects. We have not reached the point where we can explicitly tell when and how horses were introduced to the Korean Peninsula. It is unclear whether the horse culture was introduced to a region where native horses already existed or horses were brought in with the diffusion of the horse culture.

Archaeogenetics, or DNA analysis on ancient horse bones, can answer this question. The NRICH is currently conducting genetic analysis on some 140 pieces of ancient horse bones excavated from Korea, Mongolia, Kazakhstan and Russia. It is not as grand as the technology that clones dinosaurs from blood found in a mosquito trapped in amber, but we can extract quite a lot of genetic information of ancient horses, such as gender, age, maternal lineage, paternal lineage, genetic distance between horses excavated from different regions and comparison to modern horses, just from a piece of horse bone. More in-depth analysis would provide information on the cause of death and disease, and nutritional status. If we secure more samples and continue to conduct genetic analysis, we could draw a big picture of which species of horse was spread to which region around what time in ancient Eurasia.

The NRICH's project tracing the horse culture, the driving force behind cultural exchanges in ancient Eurasia, could contribute to the evolution of human history.

Lastly, the excavation site in the Altai Mountains went

❽ A horse bit excavated in Korea

down to negative 10 Celsius degrees after the sunset, just like cold winter days. In a Mongolian Ger[3], we relied on a small stove and the best fuel was well-dried horse manure. After excavating the dreary grasslands, the researchers would wander around with a bucket in their hands to find larger horse droppings. We burned the bucketful of dried horse poops to survive the long night. Literally the horse manure in this barren environment was 'salt and light' for us at the time. Lastly, on a lighter note, I express my deepest gratitude to horses of all times for greatly contributing to the development of human history for thousands of years.

3) Also known as Yurt, the traditional Mongolian dwelling is a portable, round tent with a wooden frame covered with thick felt cover to protect against outside circumstances.

Astronomical Science of Joseon Dynasty

Research Division of Artistic Heritage
PARK Jiyoung

❶ Woodblock Print of Celestial Chart Stone, 1571, woodblock print on paper, 129.0x83.0cm, National Palace Museum of Korea. ⓒ National Palace Museum of Korea

Ever-changing sky was an object of awe and study for humans. Humans have observed movements of the sky to predict climate change and natural phenomenon, advancing civilizations. In the traditional societies of premodern East Asia, reading phenomena in the sky and informing the people of the reading was considered as the king's ability and duty. Information on weather and celestial body was directly related to the development of agriculture, the main industry at the time, so astronomical science was an important means of strengthening the power of the king. Nowadays, atmosphere and universe are separately studied in meteorology and astronomy, but in the past, both of them were worshipped and observed as "Heaven."

In 1392, Yi Seong-gye, or King Taejo, founded the Joseon Dynasty (1392-1910), overthrowing the Koryeo Dynasty (918-1391). The change from Koryeo to Joseon was a dynastic revolution, in which only the political power changed with the same territory and people, so it was important for the new ruling power to justify the legitimacy of the dynasty and the revolution. Yi and the meritorious subjects who contributed to the founding of the dynasty chose Confucianism as their political ideology and claimed that they founded the new dynasty based on the "Mandate of Heaven," which means that heaven embodying all the natural order and will of the universe bestows the mandate to the ruler. In Confucianism, the ruler's basic virtues are respecting heaven and taking care of the people. So the new rulers put much effort in developing astronomy and some unprecedented astronomical instruments were invented during the Joseon Dynasty. About 20 currently existing astronomical instruments have been designated as National Treasures and Treasures by the Korean government. It includes, those used for observation of the celestial bodies, such as celestial charts and armillary sphere; time measurements such as sundial and clepsydra; and meteorological measurements such as rain gauge and wind streamer pedestal. These cultural heritages are managed and preserved by government authorities, showcasing the high level of astronomical technology during the Joseon Dynasty.

Celestial Chart Stone (National Treasure) (Figure 1, 2) was made in 1395 by some ten astronomers on the order of King Taejo, as a symbol of the establishment of the new dynasty by the Mandate of Heaven. The celestial charts were carved on the front and the back of a two-meter-high black marble. These charts are the second oldest among the surviving examples in the world, following Suzhou Star Chart, produced in China in 1241. Each celestial chart contains 1,467 stars marked with dots and includes a variety of astronomical information such as the name and location of constellations. A notable characteristic is that the dots are of different sizes depending on the brightness of a star. This is Korea's traditional and unique style, also found in ancient tomb murals of the Koguryeo Kingdom (37 BCE-668 CE).

❷ Celestial Chart Stone (National Treasure), 1395, marble, 211.0×123.0×12.0cm, National Palace Museum of Korea. ⓒNational Palace Museum of Korea

Under the reign of King Sejong, Joseon's fourth king, in the 15th century, Joseon's astronomical technology reached a world-class level. King Sejong made an armillary sphere for celestial observation, a simplified armillary sphere, and a small simplified armillary sphere, which is easy to carry around (Figure 3). King Sejong also adjusted the Chinese simplified armillary sphere to represent the latitude of Hanyang, capital of Joseon, founded the royal astronomical observatory, and ordered astronomers to watch the movements of heavenly bodies on the observatory every night. Such efforts paid off by the completion of the Chiljeongsan (Calculations of the Motions of the Seven Celestial Bodies), a calendar system based on Hanyang's latitude, in 1444. The Chiljoengsan has a historical significance in Korea's astronomy as it was the first calendar system calculated specifically to Joseon, breaking away from using the Chinese calendar system for about 1,000 years.

As observational astronomy technology developed, other time measurement devices were invented during the Joseon era. Hemispherical Sundial, referred to as Angbuilgu, the first public clock in Korea, was created in 1434 and installed on a busy street. The 1434 Sundial does not exist now, but Hemispherical Sundials (Treasure) gives a glimpse into the sundials made during the Joseon Dynasty (Figure 4). They consist of two sundials that have the same shape but differ in size. These sundials have a concave hemisphere which resembles the celestial sphere, marked with lines indicating time and seasons with a gnomon. As the sun rises and sets, the shadow of the gnomon tells the time and date.

❸ Simplified Armillary Sphere, produced in 1432, restored in 1997, Royal Tomb of King Sejong. ⓒRoyal Tomb of King Sejong

Celestial Globe and Armillary Clock (National Treasure) were created by Song Yi-yeong, who worked for Gwansanggam (Bureau of Astronomy), in 1669 (Figure 5). It combined the traditional celestial globe of the East with the mechanical alarm mechanism from the West, allowing the viewer to observe the movements of celestial bodies in real-time. This is the only existing armillary clock from the Joseon era, which is a rare combination of scientific technology of the East and the West and is a unique invention that is hard to find similar examples around the world.

A typical meteorological instrument from the Joseon era is rain gauge called Cheugugi. The instrument measures rainfalls by dipping a ruler into a

❹ Hemispherical Sundial (Treasure), late 17th century-early 18th century, bronze, (large one) height 14cm, diameter 35.2cm, (small one) height 10cm, diameter 24.3cm, National Palace Museum of Korea. ⓒNational Palace Museum of Korea

❺ Celestial Globe and Armillary Clock (National Treasure), 1669, wood and copper, 120×98×52.3cm, Korea University Museum. ⓒKorea University Museum

standardized rainwater container. Previously, precipitation was measured by gauging the depth of the soil soaked in rainwater, but the result was inaccurate as the depth differed by the quality of the soil or the duration of rainfall. From 1441 to 1442, the Joseon Dynasty produced and distributed standardized rain gauge throughout Joseon and ordered to observe and report the amount of rainfall. These were groundbreaking instruments, hard to be found in other countries of the same period, and used as Joseon's official rain gauge until the early 20th century when the modern meteorological observation was introduced to Korea. Rain Gauge of Chungcheong Provincial Office, Gongju (National Treasure) was installed at the Chungcheong Provincial Office, one of the regional offices during the Joseon era (Figure 6). According to the inscription on the rain gauge, it was made in 1837 with the height of 31.9 centimeters, diameter of 14.9 centimeters, and weight of 6.2 kilograms, which follows the rain gauge system first invented in the 15th century. This is the only existing rain gauge from the Joseon era and the oldest one in the world.

Astronomical instruments from the Joseon Dynasty play an important role not only in Korean history but also in the history of science in general. These instruments are managed and preserved through the Regular Investigations on the State-designated Movable Cultural Heritage conducted by the Korean government every five years. During the regular inspection, National Treasures and Treasures are examined for their state of preservation and environment, and the result of the investigation leads to administrative measures and policymaking. The NRICH will continue to preserve Korea's National Treasures and Treasures and share the results of research home and abroad.

❻ Rain Gauge of Chungcheong Provincial Office, Gongju (National Treasure), 1837, copper alloy, height 31.9cm, diameter 14.9cm, National Meteorological Museum of Korea. ⓒCultural Heritage Administration

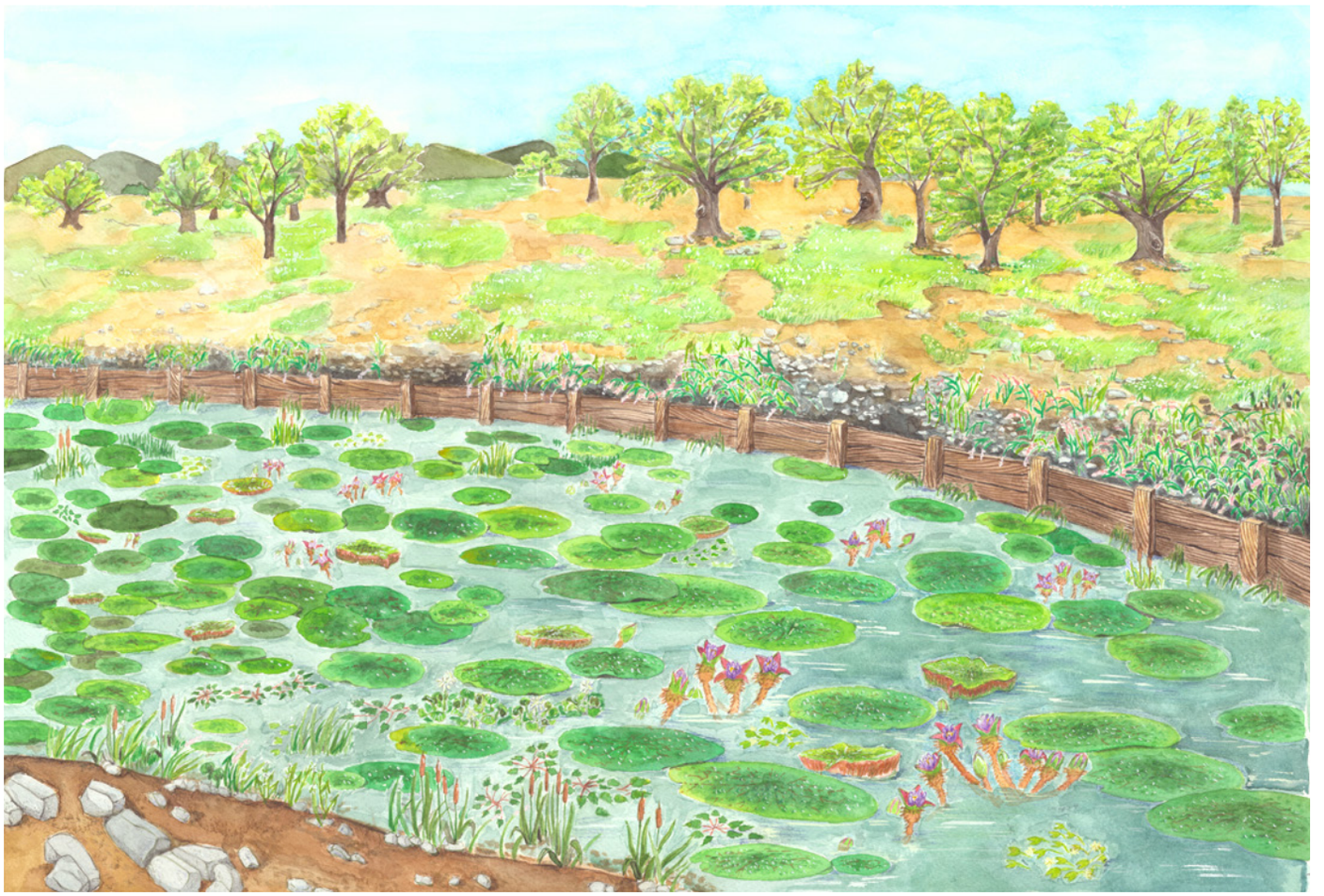
Landscape Research of Royal Palaces of Silla
Paleoecological Study on Wolseong Palace Site in Gyeongju

Gyeongju National Research Institute of Cultural Heritage
KIM Heonseok

1. Wolseong Palace Site in Gyeongju and Its Paleoenvironment

The Gyeongju Historic Areas, designated as the UNESCO World Heritage Site, includes Wolseong, the ancient palace of the Silla Kingdom (57 BCE-935 CE). The Wolseong Palace site encompasses the 1,000 year history of Silla and excavation campaigns are still underway.

❶ **The restoration drawing of the estimated landscape of the Wolseong Moat and its surroundings**



❷ Wooden structures excavated from the northern shore

One of the recent studies takes on the moat surrounding the earthen wall, giving a peek into the Silla era palace through an interdisciplinary approach. A variety of organic matters including bones, lumber and seeds were found in the 1-meter-high silt layer of the moat, providing important materials to reconstruct the environment of the area. Investigators unearthed tiny seeds, bones and clay figurines through wet sieving of the wet silt layer of the moat to estimate the landscape of the time (Figure 1).

2. The First Step of Restoring Silla Palace— Investigation on the Wolseong Moat

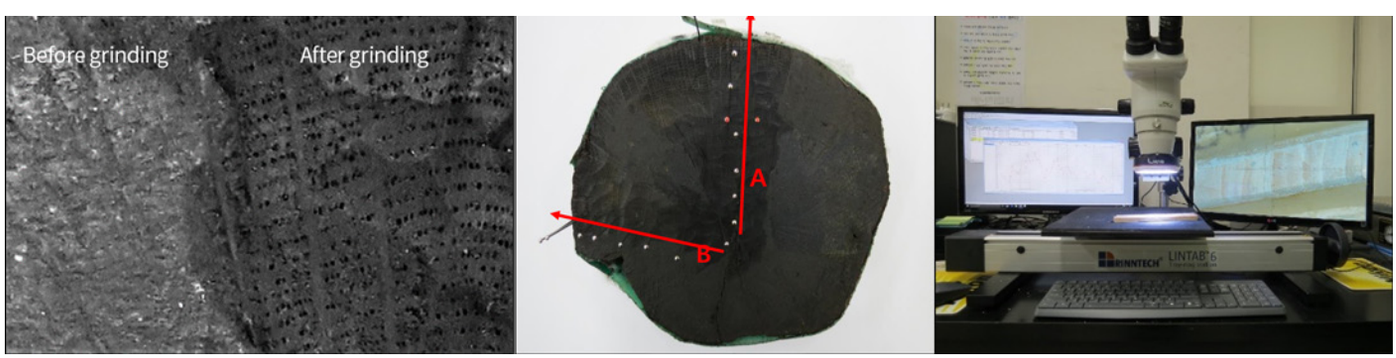
Figure 1 shows an estimated view of summer scenery in the 5th century through the investigation on the moat surrounding the Wolseong Palace. The restoration drawing is based on the results of excavations of the moat and various artifacts retrieved through wet sieving on soils of the moat.

1) Wooden Structures of the Moat and Dating of the Wolseong Moat

The Wolseong Palace site has the Namcheon Stream on its south and a moat surrounding three remaining sides of the palace ground. Investigations on the moat have been going on since the 1980s, but it took decades to grasp the whole structure of the moat. Recent excavations revealed the wooden structure on the north side of the moat (Figure 2). A wall made of wooden planks stretches out to 80 meters and estimated to cover the whole area of the northern shore.

Radiocarbon dating and tree-ring dating were used to determine the date when the wall was created.

Tree-ring dating on some 10 pieces of wooden planks from the wall revealed that most of them are from the same period (Figure 3). Since there is no dated master chronology of the



❸ Tree-ring dating (cross-section grinding, selecting directions for measurement, measuring ring width)

Three Kingdoms period in Korea, oxygen isotopes in tree rings were used to date the wood. The result showed that the moat's wooden structures were installed in 433 CE. It coincides with the determined radiocarbon dates and the chronology of pottery from the site. Radiocarbon dates of other organic matters collected from the moat produced similar results, providing evidences that the moat existed at least from the 5th century. Along with the wooden structure, the most animal and plant fluids were discovered from the bottom-most soil layer of the moat.

2) Environment Estimated From Soil From the Moat

Traces of various animals and plants used during the Silla era remain in soil deposited around the 5th century. Among the flora, the most identified is the seeds of prickly water lily with over 10,000 seeds found in the moat. In addition to the aquatic plant seeds, a variety of plants were found including grains of rice, barley, wheat and bean and fruits such as peach and plum (Figure 4). These crops are expected to be used by the people of Silla, especially those lived in the palace, suggesting that they were enjoying a varied diet. These seeds are difficult to find during the excavation, but can be found through wet sieving of deposit soil in the moat.

Except for prickly water lily seeds, grains and fruits, traces of an assortment of aquatic plants that grow in or near water were found in the moat, allowing to imagine the environment around the moat during the Three Kingdoms period. In the sediments are such aquatic plants as well as pollen of various plants. The pollen analysis suggests that Zelkova (*Zelkova serrata*) lived near the moat and Red Pine (*Pinus densiflora*) and Oak (*Quercus*) grew in surrounding forests (Figure 5). These

❹ Seeds and fruits
Seeds and fruits found through wet sieving of the Wolseong Moat soil

The sediments are deposited in various contexts—grew in the water of the moat and deposited there; naturally flew into from near the moat; and plant resources used by Silla people and artificially put into the moat.

tree species provide a basis for identifying the vegetation landscape of forests in Gyeongju.

If these trees grew in the forests near Gyeongju, people of the time might have used them for construction materials. The result of analysis on species of wood used for the wooden structures of the moat coincides with the pollen analysis (Figure 6).

The result of analyzing some 200 pieces used for the wooden structures shows that oak was the most commonly used by 58 percent, followed by Greeping Juniper (*platycarya strobilacea*) and chestnut. Using these species for construction indirectly proves that these trees grew in the forest in Gyeongju in the 5th century. Analysis on species and pollen suggest the composition of trees grew in the forest around that time.

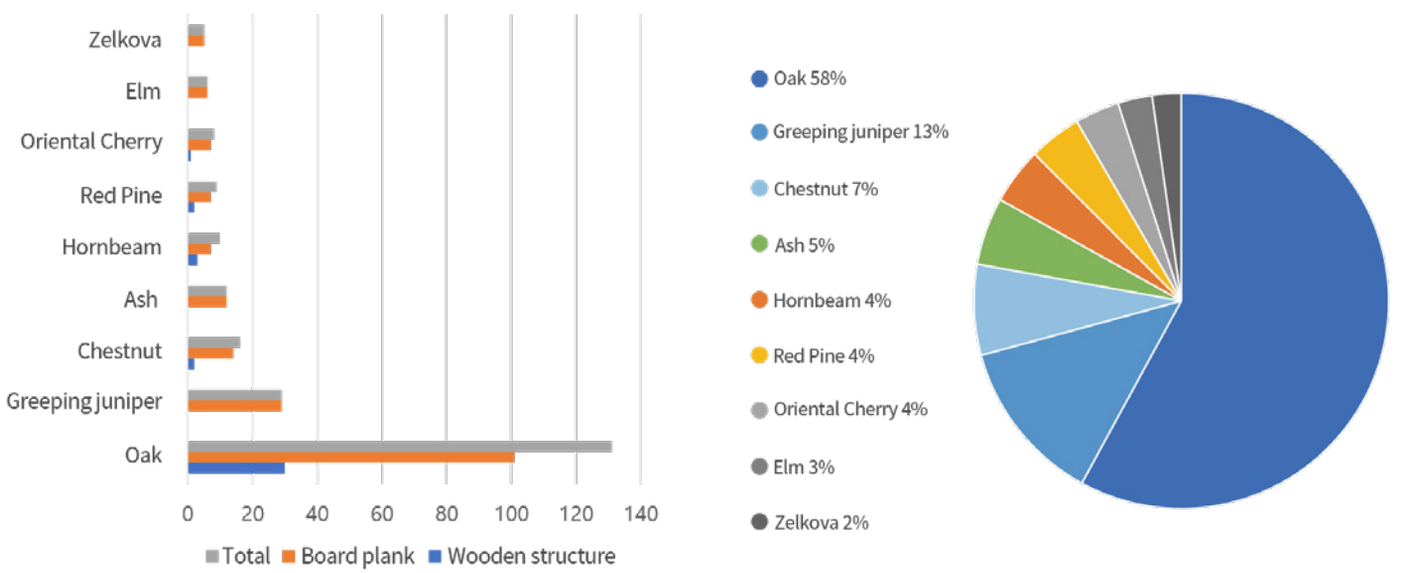
Red Pine pollen

Zelkova pollen

Oak pollens

❺ Microscope photos of pollens excavated from the deposit soil of Wolseong Moat (400x magnification)

Among pollens excavated from the deposit soil of the Wolseong Moat, those appear frequently are expected to compose the forest back then. Zelkova and oak trees grew in the riparian forest within the Gyeongju basin, while pine and oak trees lived in surrounding mountain forests.

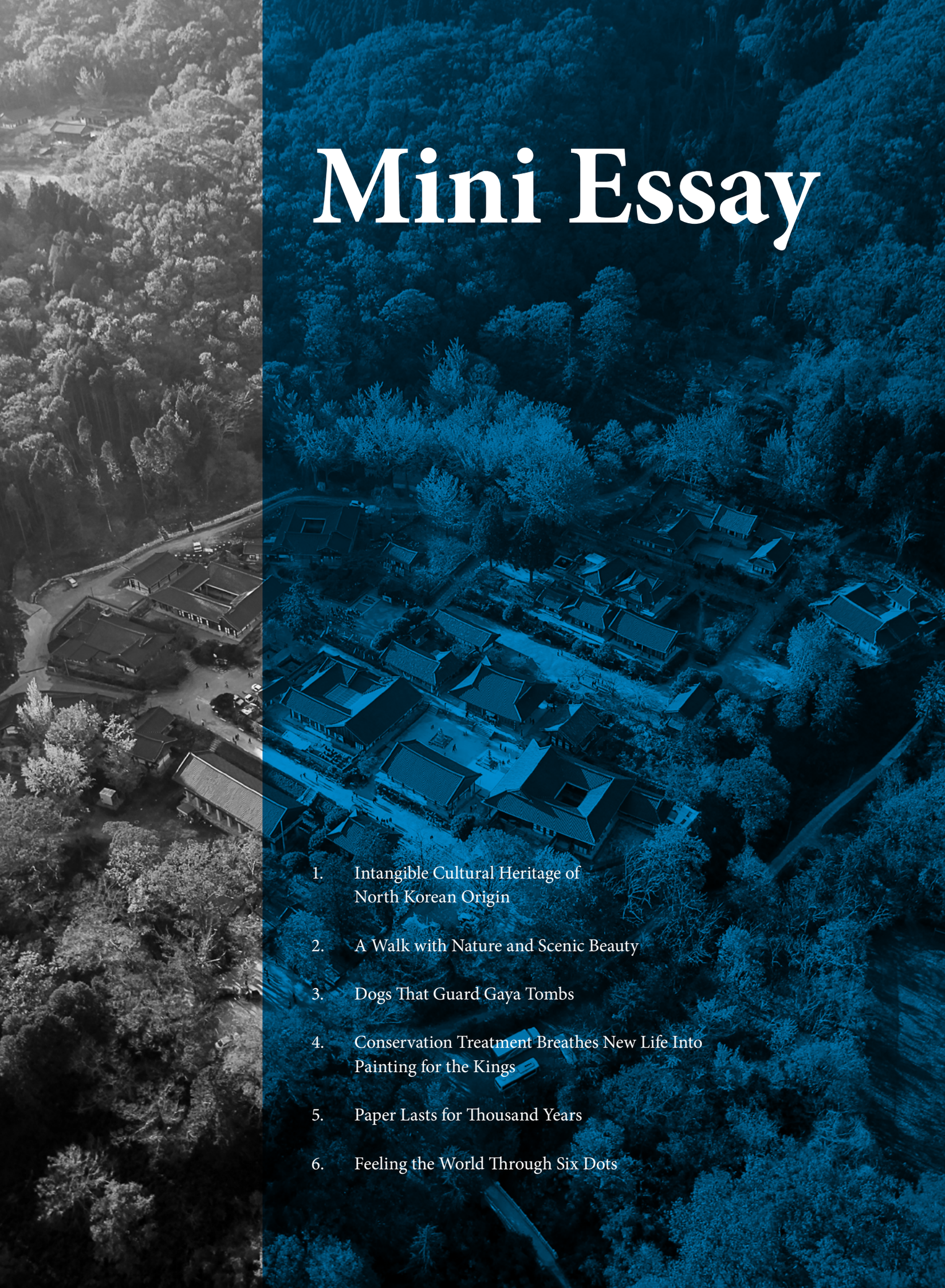


❻ Result of species analysis of the wooden structures of the Wolseong Moat

3) Silla Palace and the People of Silla in the 5th Century

Through various scientific analyses, we estimated the landscape of the Silla Kingdom in the 5th century. Currently, additional researches on animal bones and woodenware excavated from the moat (Figure 7). The silt layer of the moat includes various materials that can be used for studying the past. Researches on animal, wooden products and grains would provide more detailed looks into the life of Silla people who saw the landscape we estimated.

❼ Unearthed Animal Bones from the Moat



Mini Essay

1. Intangible Cultural Heritage of North Korean Origin
2. A Walk with Nature and Scenic Beauty
3. Dogs That Guard Gaya Tombs
4. Conservation Treatment Breathes New Life Into Painting for the Kings
5. Paper Lasts for Thousand Years
6. Feeling the World Through Six Dots

Mini Essay

Planning and Coordination Division
JI Sungjin

Intangible Cultural Heritage of North Korean Origin
Bukcheong Saja Noreum and Munbaeju Liquor



Korea's Intangible Cultural Heritage, Noreum

Let's go back in time and think of the old games Koreans used to play. We are reminded of traditional games such as Ganggangsullae (traditional Korean harvest circle dance), Geunet-twigi (swinging), Neoltwigi (seesawing), Jegichagi (Korean hacky sack) and Tuho (pitch-pot). Such traditional games carry the meanings of defeating evil spirits and wishing for a long and healthy life, happiness and peace. Noreum refers to a traditional game Korean people used to play with participating characters, composition and music. It has been passed down in various regions of Korea with its locality.

Bukcheong Saja Noreum, otherwise known as Lion Mask Dance of Bukcheong, is a folk play from Bukcheong, South Hamgyong Province in modern day North Korea. People of Bukcheong wore lion masks on the night of the first full moon of the lunar calendar in order to expel evil spirits and wish for peace of the town, believing that a lion had the power to drive away evil things. The performers from Bukcheong who defected to South Korea after the Korean War inherited this tradition and it later became designated as a National Intangible Cultural Heritage in South Korea.

Bukcheong Saja Noreum begins with a torch fight of young men on the eve of the full moon, from the 14th January through to the morning of the 15th January in the lunar calendar. The event continues through to the 16th January, with the performers visiting houses that they have been invited to within the town.

When the play begins, they go around the yard in line and start dancing up until the lion-masked performer enters. The "lion" goes into the master room and the kitchen via the courtyard and pretends to eat someone alive. Then it comes back into the courtyard and dances a lively, skillful dance and makes a deep bow to the deities of the house, including the Jowang (Kitchen God), on the request of the owner. When the lion pretends to

❶ Bukcheong Saja Noreum

fall down exhausted, the people call the great monk to recite the Heart Sutra and a doctor of Oriental medicine to apply acupuncture to invigorate the lion. Everybody then joins the dance when the lion regains its strength and teases the lion. Sometimes, small children ride the lion as it was believed that this act extends their lives and people also hang colorful patches on the lion wishing for longevity.

The Netflix Drama "Squid Game" garnered over 142 million views, becoming the platform's most-watched show ever. Korean dramas are increasingly becoming inspired by various games that Korean adults used to play when they were young. Popular games from the mid-20th century such as Ttakjichigi (paper Slap-Match), Mugunghwa Kochi Pieotseumnida (Red Light, Green Light), Juldarigi (Tug of War), Dalgona (Honeycomb Toffee Candy Challenge), Guseulchigi (Marbles) and Squeed Game (a game of offense and defense) are featured in the drama. The drama's immense popularity within and outside Korea shows how games draw interest from all ages and all countries.

References: Encyclopedia of Korean Culture, Report on Intangible Cultural Heritage

Liquor that Lightens up Tense Atmospheres

Liquor is something that appears in Korean entertainment culture and customs as it heightens the conviviality and eases difficult relationships. Munbaeju is a distilled liquor that originates from the North and its recipe has become designated as an Intangible Cultural Heritage in the South Korea. Munbaeju has played a key role in the inter-Korean relations so far. It was the official liquor of the Inter-Korean Summit in 2018 and it was also served at the Inter-Korean Summits in 2007 and 2000.

The origin of Munbaeju dates back to the Koryeo Dynasty (918-1392) and the spirit was offered to the royal family. The name comes from the Korean word Munbae, which refers to the Korean native wild pear as the liquor smells like a wild pear. Munbaeju is brewed from wheat, hulled millet, and Indian millet. Nuruk (fermentation starter) is made from wheat into a disk and it is 20 centimeters in diameter and has a thickness of 5 centimeters, while Jumo (distiller's grain) is made from hulled millet and Suldeot (mash) is blended with 40 percent hulled millet, 30 percent Indian millet, 25 percent water and 5 percent Jumo. The color of Munbaeju is light yellowish brown with a strong scent of wild pear. The fermented mash has an alcohol content around 16-18 percent and the distilled and matured Munbaeju has the alcohol level up to 48 percent.[1)]

Cultural heritage encourages exchange between the South and the North as well as finding the homogeneity of the Korean people. North Korea's games and liquor making methods have been passed down and preserved in South Korea and this is evidence of such ethnic homogeneity. Two Koreas come from the same ethnic background and have played the same games and drank the same liquor. However, due to the Japanese colonial era and the Korean War, they are divided under two separate national administrative systems until today. One day, I hope for a day when people of South and North can play traditional games together with drinks in our hands while wishing for each other's peace again.

❷ Making process of Munbaeju Liquor

1) Report on Intangible Cultural Heritage (Issue 23, December 1994, Cultural Heritage Management Bureau)

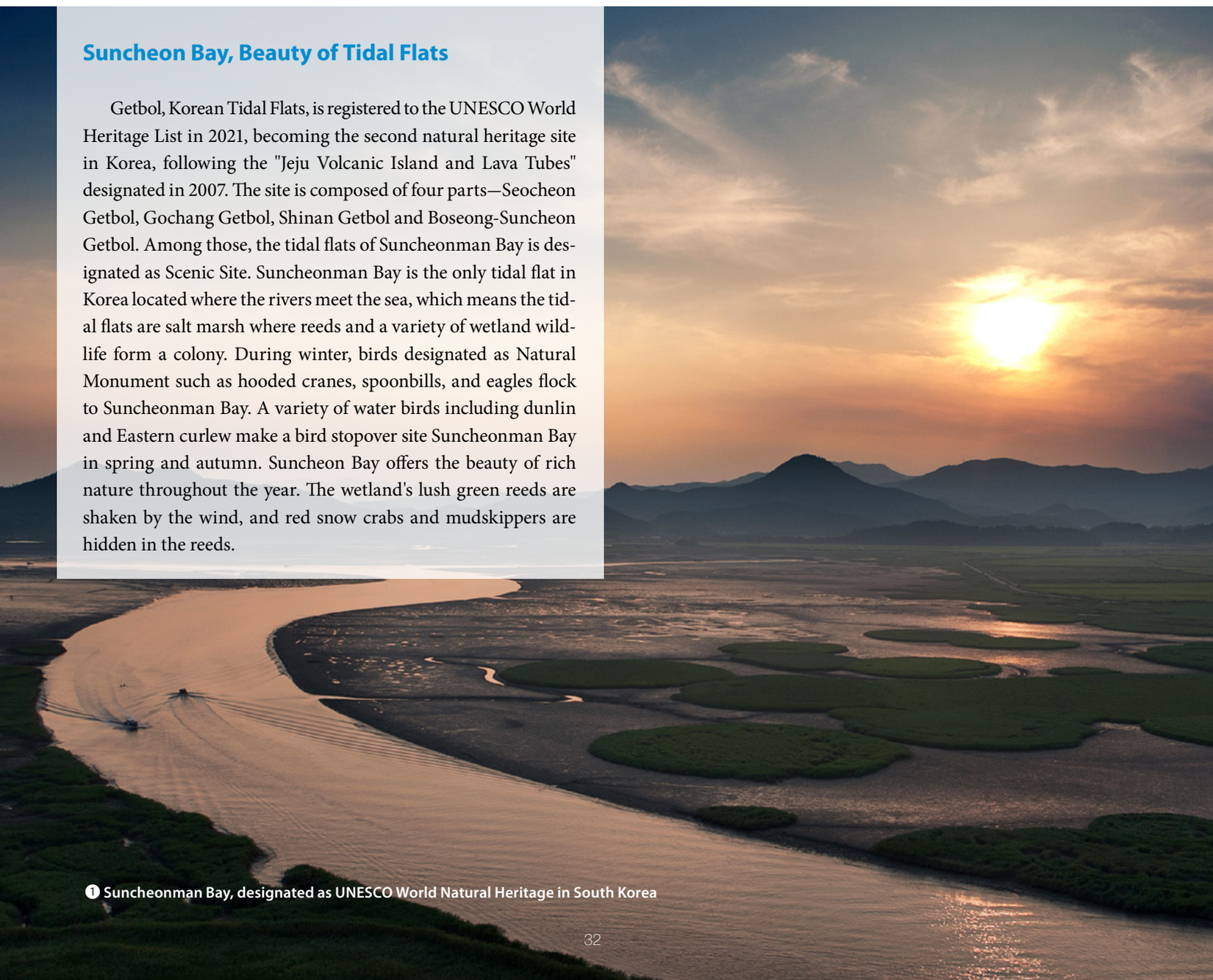
Mini Essay

Natural Heritage Division
LEE Sungkyung

A Walk with Nature and Scenic Beauty
Suncheonman, Choyeonjeong Garden and Songgwangsa Temple

Suncheon Bay, Beauty of Tidal Flats

Getbol, Korean Tidal Flats, is registered to the UNESCO World Heritage List in 2021, becoming the second natural heritage site in Korea, following the "Jeju Volcanic Island and Lava Tubes" designated in 2007. The site is composed of four parts—Seocheon Getbol, Gochang Getbol, Shinan Getbol and Boseong-Suncheon Getbol. Among those, the tidal flats of Suncheonman Bay is designated as Scenic Site. Suncheonman Bay is the only tidal flat in Korea located where the rivers meet the sea, which means the tidal flats are salt marsh where reeds and a variety of wetland wildlife form a colony. During winter, birds designated as Natural Monument such as hooded cranes, spoonbills, and eagles flock to Suncheonman Bay. A variety of water birds including dunlin and Eastern curlew make a bird stopover site Suncheonman Bay in spring and autumn. Suncheon Bay offers the beauty of rich nature throughout the year. The wetland's lush green reeds are shaken by the wind, and red snow crabs and mudskippers are hidden in the reeds.



❶ Suncheonman Bay, designated as UNESCO World Natural Heritage in South Korea

❷ Choyeonjeong Garden, Suncheon

❸ A rock inscribed with names of scholars from Joseon era

❹ Songgwangsa and Seonamsa Temples in Jogyesan Mountain

Choyeonjeong Garden, a Villa Deep Inside the Village

The Choyeonjeong Pavilion in a valley of Mohusan Mountain in Suncheon is unique, just like its name, "pavilion transcending nature." Located in a deep mountain valley at the back of a village, Choyeonjeong Pavilion is placed at an unlikely spot at the end of a winding road making one wonder if there can be such venue in this deep forest. The garden area is divided into the "inner garden" where the pavilion is located and the "outer garden" in the valley area. The outer garden has calm, limpid waters against the backdrop of screen-like rocks, which is an example of Korean traditional landscape architecture bringing the aesthetics of the natural environment into the garden.

A Place for a Pause, Songgwangsa Mountain Temple

Suncheon has another scenic site in addition to Suncheonman Bay and Choyeonjeong Garden—Songgwangsa and Seonamsa Temples in Jogyesan Mountain. Songgwangsa Temple is one of the "Three Jewel Temples" in Korea, which include Tonngdosa Temple representing the Buddha, Haeinsa Temple representing Buddhist teachings and Songgwangsa Temple representing the Buddhist community. So visitors can often witness Buddhist monks gathered to concentrate on Buddhist practice in the Songgwangsa Temple. When you pass through the Iljumun (main gate of the temple) and walk along a forest pathway, a pavilion bridge called Cheongnyanggak appears. Like the bridge's name "cheongnyang," which means refreshing in Korean, the bridge is located over a valley with crystal-clear water from Jogyesan Mountain, suggesting the visitors wash away the secular concerns here. In the temple's precincts, the Imgyeongdang Hall, where the monks reside, has a protruding upper floor, which makes the building like a pavilion than a temple, showcasing the characteristics of Songgwangsa Temple focusing on harmony with nature. Chimgyeru Pavilion is a two-story pavilion located over a valley as its name means "lying along the valley."

The temple's main building, Daeungbojeon, has beautiful yet faded dancheong (traditional multicolored paintwork on wood), reflecting how old the temple is. Making a long stay at Songgwangsa Temple is a great way to fully absorb the temple's actual charms.

Mini Essay

Gaya National Research Institute of Cultural Heritage
KIM Bosang

Dogs That Guard Gaya Tombs

❶ Dog bones in the small-lined stone chamber of the Tomb No. 63

Dogs are the first animals to be domesticated by humans, living with humans assisting hunt, shepherding sheep, guarding and as a pet. The excavation campaigns of the Gyo-dong and Songhyeon-dong Tumuli in Changnyeong yielded skeletal remains of dogs which date to the Gaya period.

The dog bones were discovered while removing small stones in front of the Tomb No. 63. At first, it was difficult to identify what animal it was and how many of them were buried as the inside was filled with soil. As the dirt was brushed off carefully for a long time, it was revealed that it was a dog-like animal with the skeletal remains relatively intact. There was a room for the animals and the animals were laid facing the outside of the tomb. Investigators have found that the animals were dogs. The animals were not placed between stones as offerings, but three dogs laid down in a complete form in a small room near the tomb occupant suggested it was an example of Sunjang, or sacrificial burial burying the living with the dead, a custom of the Three Kingdoms period.

Excavation of Tomb No. 39, which is 27.5-meter-long, also confirmed a small space near the entrance with parts of animal bones. As an investigator, the animal bones are expected to be those of dogs, similar to Tomb No. 63, but cannot guarantee since it was impossible to estimate the whole skeletal system. The two tombs touched each other, which suggests that the owners of the tombs are relatives. Both tombs added a small stone-lined chamber near the owner on northwest of the entrance and buried animals there. What was the duty of the dogs buried in the Tombs No. 39 and 63?

The recent excavation of the site unveiled new things that are not found in different tombs of the same era with little known. We are examining what we have found after returning to the institute. Burying dogs at in a separate room near the entrance of a tomb seems different from the animals had been discovered at the other tombs of the Three Kingdoms period. The dogs might have played the role of Jinmyosu (tomb guardian animal) like the dog appearing in the mural of the Gakjeochong (the Tomb of Wrestlers) from Koguryeo or a stone guardian from the Tomb of King Muryeong in Baekje.

Nowadays, we often see people walking with their dogs, reflecting that dogs are great companions of humans. The dogs stand by their owners whether alive or dead.

❷ The small stone-lined chamber near the entrance to the Tomb No. 63

❸ Guard dog described in the entrance of the Gakjeochong (the Tomb of Wrestlers)

❹ Stone guardian (King Muryeong in Baekje)

Mini Essay

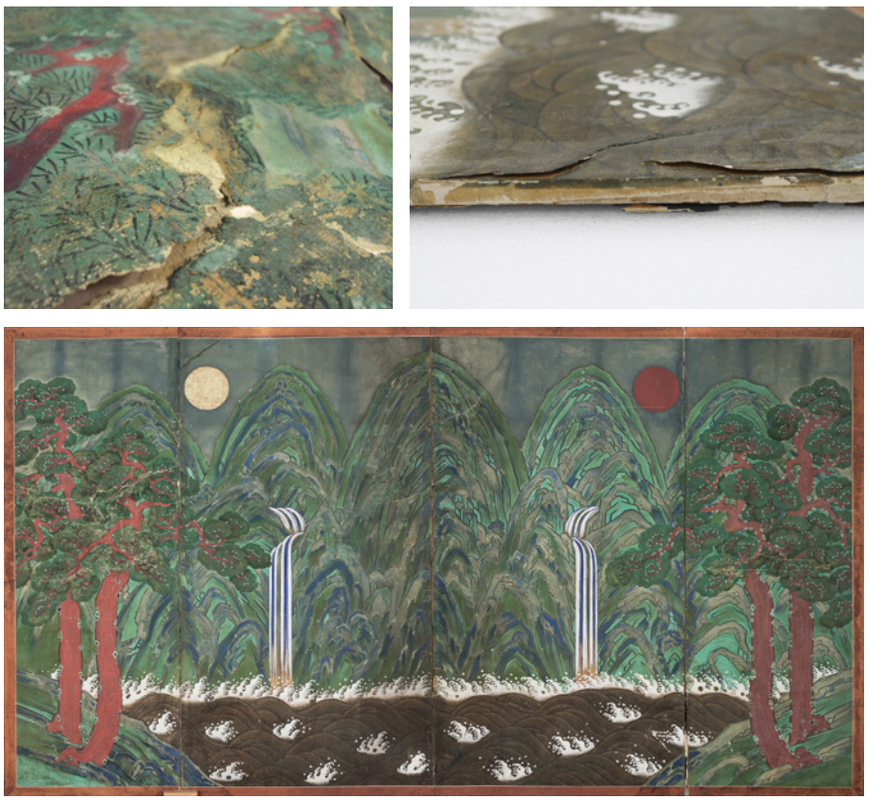
Cultural Heritage Conservation Science Center
JEONG Heewon

Conservation Treatment Breathes New Life Into Painting for the Kings

Restoration Process of Irworobongdo from Injeongjeon, Changdeokgung Palace

Conserving cultural heritage which bears our history and tradition is an important task. The Cultural Heritage Conservation Science Center under the NRICH puts much effort into protecting the original state of cultural heritage while ensuring them to be well maintained in the future. Restoring damaged and missing parts of artifacts and reinstating them back to their original locations, is one of the most accomplishing moments for conservation scientists, redeeming their hard work. The conservation treatment of Irworobongdo (Painting of the Sun, Moon and Five Peaks) which began in 2015 has been a rewarding project as such.

STEP 1
Damaged Irworobongdo transferred to the NRICH



❶ Irworobongdo before conservation treatment

In December 2015, Irworobongdo with significant damage on the screen and frame was transferred to the National Research Institute of Cultural Heritage. The damage was very serious including exfoliated pigments and torn screen panels. The Irworobongdo was originally placed behind the throne in the Injeongjeon Hall of Changdeokgung Palace. The main building of the second royal palace of the Joseon Dynasty was a poor environment to preserve a silk folding screen since it was exposed to external environmental change. The Cultural Heritage Conservation Science Center checked on the condition of the Irworobongdo and discussed the appropriate conservation treatment method with the Changdeokgung Palace Management Office before starting the process.

STEP 2
Research on the current state of Irworobongdo

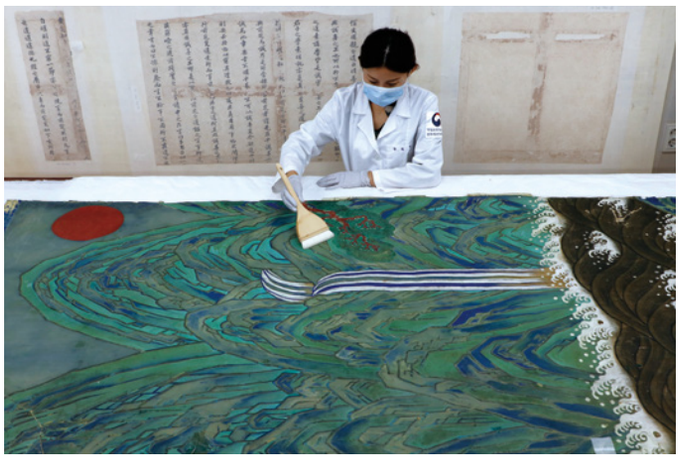
"When we inspected the status of Irworobongdo, there were many damaged parts that were torn or ripped. We had to run a thorough inspection before the conservation treatment could start."

For conservation treatment, the first thing to do is to identify damage such as tear, loss, stain and peeling-off and classify those by types. Infrared imaging reveals invisible lines and underdrawings beneath the surface painting layer. This preliminary investigation plays a key role in decision making for conservation treatment methods.

❷ Taking photographs of Irworobongdo with a microscope

"Irworobongdo has been through conservation process in the past. It is possible to confirm the newly painted-over parts through infrared imaging. Pigments that fill in the lost parts and those that are painted over on original pigments differ in color."

The material used to make Irworobongdo also has to be identified to fill the torn or damaged and lost part with similar materials. Researchers analyze the fabric, whether it is silk, hemp or ramie, and how it is woven. After inspecting the status and analyzing the material, the conservation treatment plan for the artifact is established before the treatment is actually implemented.



❸ Dry cleaning

❹ Pigment

"We have researched in many ways to restore Janghwang (traditional Korean mounting). Sinseonwonjeon Hall of Changdeokgung Palace is where portraits of deceased Joseon kings were enshrined and there is another version of Irworobongdo. We referred to that painting to restore the back of the folding screen. We pasted blue paper with the Buddhist Swastika pattern (卍) on the back of panels 1 and 4 and plain white paper on the back of panels 2 and 3, according to historical evidence."

After completing these steps, the painting that has been treated is attached to the front of the folding screen. The final step is to decorate the edges of the painting with silk as in traditional Korean mounting. The final adornment is also based on data from Uigwe (Royal Protocols of the Joseon Dynasty), gelatin dry plate and similar artifacts. Green silk with cloud pattern was used for mounting, completed with red and white linings. Silk with flower-patterned gold leaves was applied around the edges of the painting, adding the finishing touch to the conservation treatment.

STEP 3
Supplementing over and over

"Before we start the treatment, we stabilize the pigment which might peel off or exfoliate from the surface. Then we do dry cleaning, by removing contaminants from the surface with a dry brush, and separate each painting from the folding screen frame. Then we go through the wet cleaning process by spraying water to reduce contamination on the surface."

After removing the surface dust, conservators add a new layer of backing paper called "Baejeobji", on the back of the painting. In the past, backing paper was used to make the painting thick and durable. Irworobongdo also has multiple layers of backing paper, but over time the old backing paper has deteriorated and peeled off, so a new layer is needed.

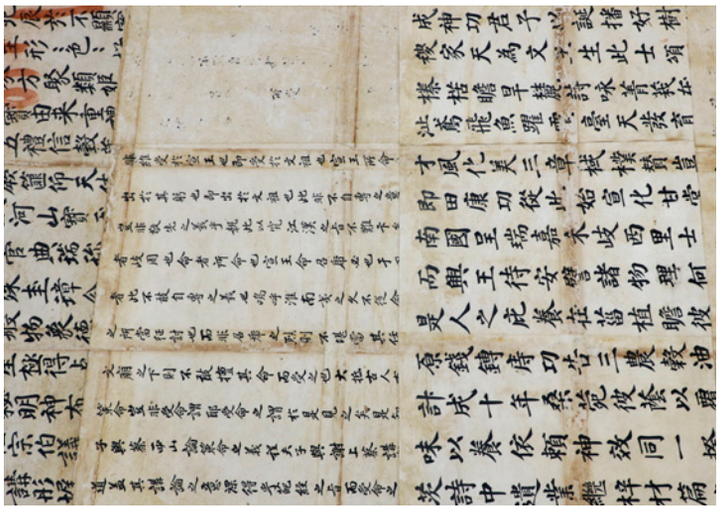
"In the front of the painting, there are parts that have fallen off. We restored the lost parts by weaving silk pieces similar to the original painting. Then the restored part is matched with the original texture and color."

The first and foremost principle of this process is not to restore the unharmed parts of the original. Restored parts should be added in reversible methods so it does not damage the original if removed. The folding screen frame was also too old and damaged by insects to be used. A new frame was made from pinewood with added layers of paper to mount the painting.

❺ Removal of old lining paper

❻ Matching the restored part with its original texture and color

❼ Applying silk around the edges in Janghwang (traditional Korean mounting)



❽ Gwageo (highest-level state examination) answer sheets used as backing paper

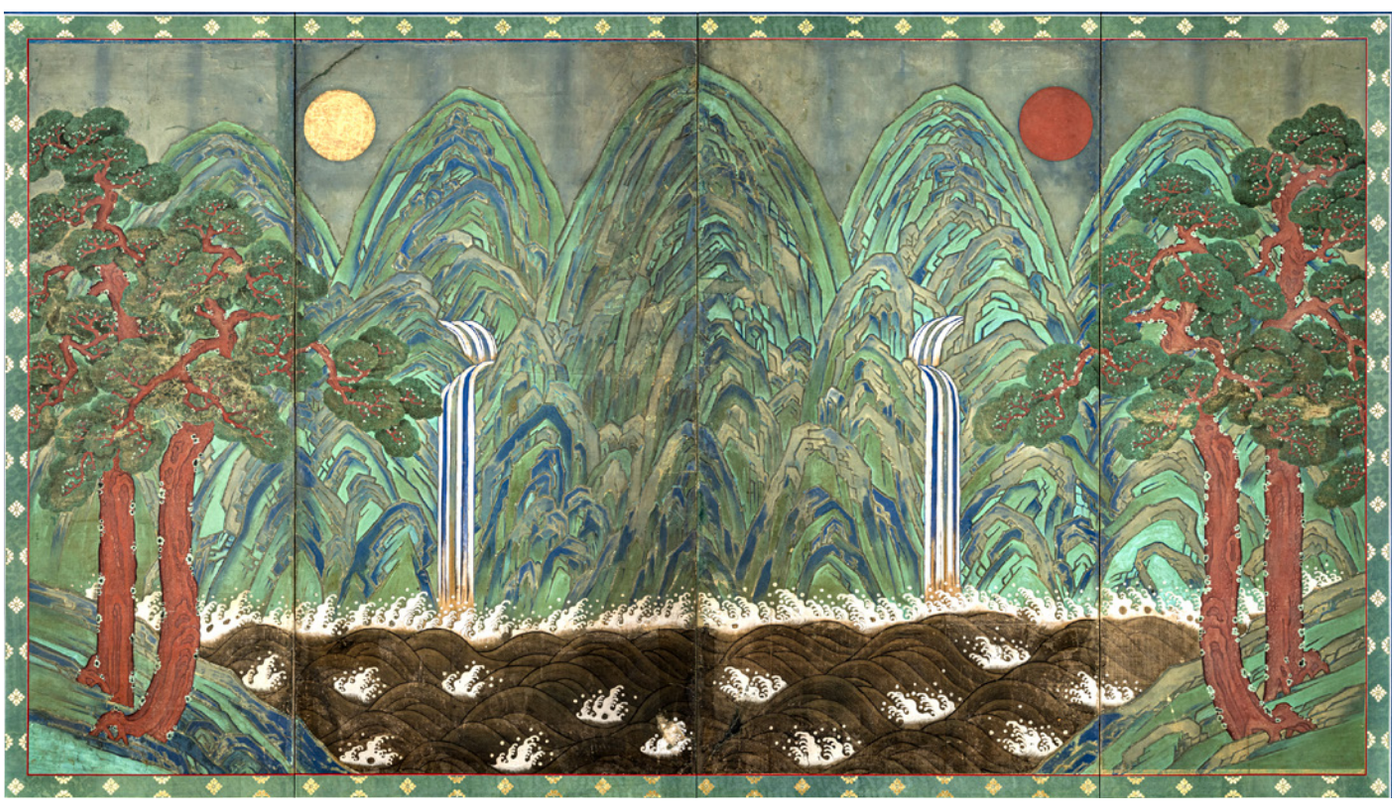
FINAL STEP
Importance of documenting the conservation treatment

An unexpected discovery was made while restoring the Irworobongdo. "When we disassembled the folding screen, we found newspapers from the 1960s and older documents underneath. When we consulted experts to identify those documents, they suggested that the papers were answer sheets of applicants who failed the Gwageo exams (highest-level state examination of the Joseon Dynasty for selecting government officials). It appears that those answer sheets were reused as backing paper. These are now going through more detailed research to estimate the age."

The conservation treatment of Irworobongdo began in 2015 and has been completed in 2021. However, the task of the Cultural Heritage Conservation Science Center is not yet done. They have to document the results of investigation and research conducted during the restoration and conservation.

"Conservation treatment is a moment when we can meet the cultural heritage at the closest. We try to document precious information gained from the encounter and record the conservation methods taken, in as much detail as possible to help future conservation treatment of other artifacts."

History is told through records. Through records, we meet the past, connect with the present and continue on to the future. We hope the result of this conservation treatment can provide assistance in breathing new life into other cultural heritage.



❾ Irworobongdo after conservation

Mini Essay

Restoration Technology Division
JEONG Seonhwa

Paper That Lasts for Thousand Years
Hanji (Traditional Korean Paper) Used for Restoration of Cultural Heritage

Traditional Korean paper, Hanji

The excellence of Korean Hanji was proven by the Mugujeonggwang Daedaranigyeong (Great Dharani Sutra of Immaculate and Pure Light), discovered in Three-story Stone Pagoda of Bulguksa Temple, Gyeongju, Gyeongsangbuk-do Province, in 1966. The sutra, designated as National Treasure, is known as the world's oldest woodblock print. It is estimated to be printed before 751 during the Unified Silla Kingdom (668–935), which is approximately 1,200 years ago, verifying the long-lasting quality of Hanji.

According to the Standard Korean Language Dictionary, Hanji is defined as paper made with Korea's unique manufacturing technique using fiber from paper mulberry. Our ancestors made good use of the various properties of materials to make traditional Hanji. They collected skins of Korean native paper mulberry in late autumn and cooked them with natural alkaline solution lye water and used hibiscus manihot root mucilage as a dispersing agent.

Hanji can be largely divided into "traditional Hanji" and "improved Hanji." Traditional Hanji is produced with fiber from the bark of Korean paper mulberry, cooked with natural lye water made by ashes from burning Yukjae (sesame stem, rice straw stem, buckwheat stem, cotton stalk, pepper stem and beanstalk). Then it is washed and naturally bleached by sunlight, running water and snow and mixed with hibiscus manihot root mucilage in "jitong" case. The fibers are strained and refined for each sheet of handmade paper. The production method and equipment have evolved and improved as times have changed. Nevertheless, traditional Hanji sheets are made smooth and even by hand, keeping the characteristics of long, resilient fibers of Korean paper mulberry. Heullim tteugi is the technique which makes the fibers to flow naturally within the sheet and after the fibers are drafted, the paper goes through dehydrating and drying. The surface of the paper can be further smoothed by pounding with a mallet.

Modified Hanji is distinguished from traditional Hanji as it is made by mixing different fibers and imported paper mulberry trees. Chemical cooking liquors such as sodium hydroxide (caustic soda, NaOH) and sodium carbonate (soda ash, Na_2CO_3) are used and Polyacrylamide (PAM) is used as a dispersant. Sodium Hypochlorite bleaches the paper and knife beater machines cuts the fibers short to make them even. The sheet of paper is drafted in a way which the orientation of the fibers is fixed. After dehydrating, the paper is dried on a hot plate. Such modified methods contribute to the even formation and brightness of Hanji, but compromises its durability, making it less suitable for keeping for a long time.

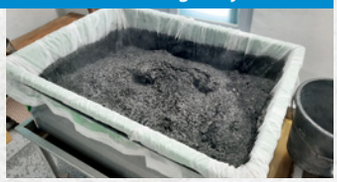
Scientific analysis to verify traditional materials for cultural heritage

There are many cultural heritage in Korea along with the country's long history. According to the Cultural Heritage Protection Act, "cultural heritage" refers to heritage of outstanding historic, artistic, academic or scenic value, which includes Tangible Cultural Heritage including National Treasure and Treasure, Intangible Cultural Heritage, Folklore Cultural Heritage, Natural Monument, Historic Site and Scenic Site. Among them, Hanji is a major material for paper cultural heritage including documents and paintings, which falls into the category of Movable Cultural Heritage under Tangible Cultural Heritage. The paper cultural heritage of organic material is often harmed by diverse artificial, physical and environmental damage factors. When the damage is serious enough to harm the original status, the paper artifact goes through conservation treatment. Scientific research and analysis on the material of the original determines the restoration material. The scientific study is conducted in a non-destructive way to retain the original condition.

Before the scientific analysis, a preliminary survey is conducted to observe the overall conservation status of the object such as shape, size and damage condition, taking photographs and documenting the details. Scientific analysis on paper includes material investigation and structural and component analysis, which meas-

Major and supplementary materials for making Hanji

White bark of paper mulberry



Natural ashes

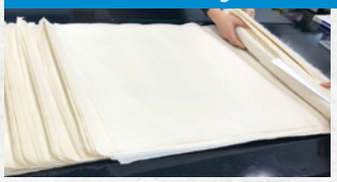
Hibiscus manihot root mucilage

Heullim tteugi (a way of drafting fiber to make a sheet of paper) for Mungyeong Traditional Hanji

Gadum tteugi for Sinhyeonse Traditional Hanji

Final product of Hanji

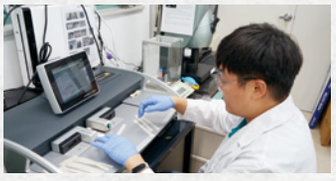
Research of restoring the traditional pigment used for Dancheong



Sample screening

Sheet analysis

Measuring folding endurance



Measuring tensile strength

Observing through stereoscopic microscope

Measuring color difference

ures thickness of the original paper, the intervals of stitches and the number of strips in screen marks, chromaticity (L*, a*, b*) and acidity (pH). Then other scientific analyses such as identification of fiber, scanning electron microscope (SEM), Fourier transform infrared spectroscopy (FT-IR) and X-ray diffraction (XRD) are also conducted on the paper object to find the Hanji in similar quality to use for restoration.

NRICH ordered and produced Hanji for repair and restoration with specific settings on materials and processes, in order to test and analyze the ingredients and manufacturing processes of Hanji. To evaluate the quality, the optical, physical, chemical, structural and biological properties of Hanji are analyzed and artificial accelerated deterioration test in dry, wet and high temperature conditions are conducted.

NRICH published *Korean Paper Hanji – Production Process Research* in 2020, compiling the result of study on the manufacturing process of Hanji suitable for repairing and restoring cultural heritage. There is a Korean saying "Silk lasts 500 years, but Hanji lasts 1,000 years" and the research result showcases durability and scientific credibility of Hanji, which could increase the use of Hanji in repair and restoration of cultural heritage inside and outside Korea.

How far will you allow applying Hanji in the restoration and conservation of cultural heritage?

Hanji can be used in conserving paper heritage such as books, documents and paintings. In the conservation of books, the book is divided into cover, end paper and text block and damaged parts go through treatments such as replacing missing parts, applying anti-bending reinforcement for wrinkled and bent parts, adding backing layers to support the original artifact, mounting of scroll and album and making a replica.

Hanji for repair and conservation is chosen based on the needed use and objective of the conservation treatment. The most important element to consider for the paper to be used in restoration is its stability and preservability. Traditional Hanji is the most utilized material for restoration as it is made from Korean paper mulberry bast fiber and hibiscus manihot root mucilage, which are natural materials similar to the material of already existing cultural heritage. Based on expert advice and consultation, traditional Hanji-making materials are used, but both traditional and modified methods are used in beating, sheet-making and drying processes to improve formation of paper. To make Hanji used for preserving cultural heritage, we strictly control traditional materials, but employ modified manufacturing techniques as necessary. However, these modified techniques have to secure the stability and preservability of Hanji.

The Restoration Technology Division of NRICH is planning for further research on quality standards of various restoration paper, which will be not only for paper heritage but also for restoration paper such as wallpaper requiring functionality to original paper for architectural heritage and such as craft paper for modern cultural heritage, and tries to eliminate the risk of indiscriminate use of restoration paper and to contribute the utilization of high-quality, reliable traditional materials.

Cover of Korean Paper Hanji - Production Process Research, a research report on Hanji published by the NRICH

Mini Essay

Research Division of Archaeology
LEE Chorong
Natural Heritage Division
LEE Sungkyung

Feeling the World Through Six Dots

Stories of the Wise Pre-historic People and Stories of the Natural Heritage Animals, from the Series Touch and Sound Multimedia Braille-Tactile Books

❶ Volunteers who donated their voice to audio commentary of multimedia braille-tactile books

❷ NRICH's first braille-tactile book in the field of archaeology: Stories of the Wise Pre-historic People

Braille is the only language system for the visually impaired. About 60,000 books are published every year in Korea, of which only about 10 percent are available for the visually impaired, causing a knowledge gap. Books allow readers to learn and experience worlds they have never experienced before. Which is why everyone should have equal opportunity to read. The NRICH is publishing braille-tactile books for the visually impaired.

The first braille-tactile book in the field of archaeology

As Hallyu, or Korean wave, spreads globally, interest in Korean cultural heritage also increased considerably. However, certain groups of people in Korea, such as the visually impaired, do not have access to accurate information on cultural heritage or are even exposed to wrong information. The National Research Institute of Cultural Heritage publishes braille-tactile books to provide accurate and reliable information on cultural heritage for the social minorities, including the visually impaired.

Stories of the Wise Pre-historic People is the very first piece of media content for the visually impaired covering ancient history. The braille-tactile book is accompanied by audio commentary and interesting sounds to satisfy people's curiosity about cultural properties. Braille texts combined with sounds provide easier understanding of the detailed shapes of the portrayed objects. All of the braille letters were produced with non-toxic natural ingredients. The illustrations are also marked with embossed dots which allows for much better understating of the images. Illustrations and explanations are on the left pages, while the right-hand pages contain the prehistoric stories in texts. A unique interactive audio pen is included in the book which can read the texts out loud and play the sound effects.

The book's theme is the Old Stone Age, or the Paleolithic Era, which refers to the prehistoric period dating back to roughly 2.6 million years ago with the earliest evidence of humans using stone tools, and lasted until 10,000 BCE. Interestingly, some of the behavioral patterns and cultures formed in the Old Stone Age persist today. Chipped stone tools have evolved into the knives and axes we use now. The custom to bury a

person in a grave with flowers on the bodies also traces back to the Old Stone Age. However, we often mistake the Paleolithic culture. We call the anthropoids primitive and consider them barbaric. The book *Stories of the Wise Prehistoric People* provides an opportunity to correct such misconceptions and think about the times through stories related to archaeological sites and artifacts of the Old Stone Age in Korea.

The book consists of three chapters. Chapter 1 introduces the stories of the Paleolithic people, while chapter 2 introduces some archaeological sites in Korea and artifacts excavated from the sites. The last chapter answers frequently asked questions about the Old Stone Age.

This braille-tactile book is for the socially disadvantaged who might have difficulties accessing information on cultural heritage. Many people voluntarily participated in the making of this book. Lee Hanyong, the director of the Jeongok Prehistory Museum and professor Seong Chuntaek of Kyung Hee University supervised the overall contents and detailed illustrations are examined by Kim Soyoung, a curator of the Jeongok Prehistory Museum. For braille translation, the Daejeon Braille Library translated and proofread the text based on the Korean braille standards issued by the National Institute of Korean Language. K-pop singers Lee Jun-ho of 2PM and Kai of EXO, actor Cha Taehyun and MBC newscasters Heo Ilhu and Kim Chorong contributed their voices for the audio commentary recordings. The book was published in early December 2021.

❸ Inside of the braille-tactile book on animals designated as Natural Monuments

❹ The DMC Children's Choir from Daejeon City volunteered to sing songs for the book

Second Braille-Tactile Book Upgraded Reflecting Readers' Opinions

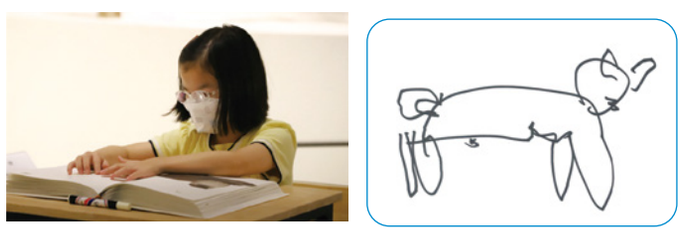
Another braille-tactile book on Natural Monuments was published in 2021. This book introduces 70 species of animals designated as Natural Monuments. It describes the animals' appearances and characteristics through folk songs related to the animals and with the patented "water drop" braille letters, which are made of natural ingredients. With the interactive audio pen, readers can hear the animals' sounds and songs about them, providing richer experiences.

Various Korean people and enterprises took part in making of the braille-tactile book. People voluntarily participated in a fundraising campaign for the book. From April to June 2021, the AIA Life Insurance and SK C&C co-operated to launch the mobile application "AIA Vitality x T Health Habit" for a walking campaign. A total of 12,983 citizens took part in the campaign and the number of their steps were converted into project funds for the braille book. Fifty-nine citizens, as well as celebrities, donated their voices for the audio commentary. Footballer Son Heungmin read the article on the Golden Eagle, while actor Song Joongki's voice was used for the story of the Hawk, Musk Deer, and Owl. The DMC Children's Choir from Daejeon City sang the children's songs and folk songs featuring the animals and vitalized the book.

The book, which was initially published in 2020, was improved to a great extent in 2021, with supplement is based on visually impaired readers' feedbacks. Braille dots were raised higher than those from the previous publication, and the illustrations were simplified to improve the legibility. Directions for the interactive audio pen was also added for easier use. The NRICH distributed the book to 534 visually impaired children on October 15, commemorating the White Cane Day. The NRICH will continue to publish braille-tactile books on cultural heritage and expects to establish a sustainable impact.

Tactile experience through braille book

❺ A Jindo dog imagined by a visually-impaired child before reading the braille-tactile book



❻ A Jindo dog imagined by a visually-impaired child after reading the braille-tactile book

NRICH Inside

Around NRICH

Publication

National Research Institute of Cultural Heritage to Lead Future of Cultural Heritage Research

– NRICH Changes Official Korean Name –

The National Research Institute of Cultural Heritage (NRICH), an affiliate of the Cultural Heritage Administration (CHA), changed its official Korean name from Gungnim Munhwajae Yeonguso to Gungnim Munhwajae Yeonguwon on Feb. 22, 2022. The NRICH was first established as the Cultural Heritage Research Office under the Cultural Heritage Bureau of the Ministry Culture and Information on November 5, 1969. The Institute was renamed to the NRICH under the Presidential Decree on November 22, 1995.

The change of the name comes from the institute aiming to respond proactively towards the recent emergence of the Fourth Industrial Revolution and change of research environment such as state-of-the-art technology including artificial intelligence, 3D data and non-contact analysis, convergence research based on cultural heritage knowledge resource and systematic and scientific cultural heritage analysis.

The NRICH is the only national institute comprehensively studying cultural heritage, researching a variety of cultural properties in various fields from archaeology, art history, and architecture to conservation science, natural heritage and safety and disaster prevention. Currently, the institute has two divisions, seven research divisions and a center with seven regional institutes to cover each cultural area.

In the last 53 years, the NRICH has conducted excavation, restoration and conservation on important national cultural properties. The institute's major achievements includes the excavation of Cheonmachong Tomb in Gyeongju, Tomb of King Muryeong in Gongju, Earthen Fortification in Pungnap-dong, Seoul and Gyeongbokgung Palace; restoration of Stone Pagoda at Mireuksa Temple Site and Stupa of State Preceptor Jigwang from Beopcheonsa Temple Site, Wonju; scientific conservation of Signboard of Sungnyemun Gate and Clepsydra of Changgyeonggung Palace; discovery of natural heritage such as footprints proving courtship of carnivorous dinosaurs; and survey on some 37,000 Korean cultural heritage overseas from eight countries.

In the future, the institute will continue to develop technologies for restoration and conservation of cultural heritage and nurture related industry by building a digital archive of cultural heritage including 3D data for digital restoration, documentary heritage big data and immersive contents on natural heritage and sharing it with the public and cultural heritage research and development (R&D) project covering intelligent exploration equipment and smart technology in response to disaster.

Upon the legislation of the "Special Act On The Maintenance Of Historical And Cultural Zones," seven regional institutes in Gyeongju, Buyeo, Gaya, Naju, Jungwon, Ganghwa and Wanju will become the base for research cooperating with related organizations and local governments and research and promote Korea's cultural heritage through projects such as a research on the value of world heritage in the Demilitarized Zone (DMZ), inter-Korea cultural heritage research and rectification of East Asia history.

The change of official name in Korean will lead to a more organic and systematic operation of the NRICH and regional institutes and strengthen research capacity to play a pivotal role in cultural heritage research.

NRICH Completes Conservation Treatment of Korean War Relics

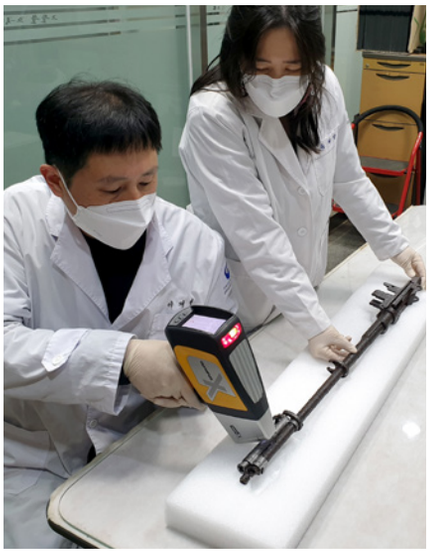
The National Research Institute of Cultural Heritage (NRICH) completed conservation treatment of 417 items from 309 cases excavated from Arrowhead Ridge inside the Demilitarized Zone (DMZ) and transferred the objects to the Ministry of National Defense (MND) on December 23, 2021.

Arrowhead Ridge, located in Cherwon, Gangwon Province, is one of the fiercest battlefields during the 1950-53 Korean War where South Korean and French soldiers of the United Nations Command fought against invading Chinese forces in 1953. Among the articles left by the deceased that went through conservation contains of 73 items in 50 identified cases and 344 items in 259 unidentified cases. The items range from private items such as two dog tags containing the fallen soldier's military serial number, name and blood type, dog tag chains, military boots and canteen to combat gear including M1 Garand's trigger, M1 bayonet, helmet and cartridge belt.

The NRICH cooperated with the Ministry of National Defense's Korean War remains excavation project and conserved 545 items from 69 cases unearthed in the Arrowhead Ridge in 2020. The Arrowhead Ridge was a site for many fierce battles during the Korean War from 1951 to 1953. It was in the "Iron Triangle" area where South Korean, American and French soldiers fought against the North Korean and Chinese army. NRICH will assist conservation treatment of the Korean War relics, providing data and establishing plans for the conservation of modern cultural properties.

❶ Ministry of National Defense (MND) Agency for Killed In Action (KIA) Recovery and Identification searches for remains of fallen troops at the Arrowhead Ridge
ⓒMinistry of National Defense

❷ Relics after conservation treatment



❸ Conservation treatment on artifacts of Korean War victims

19-Meter Koryeo Era Bastion Discovered in Ganghwa Castle

The Ganghwa National Research Institute of Cultural Heritage discovered a large-scale Chiseong (bastion) at the Jungseong Fortress on Ganghwa Island, off Korea's west coast, in December.

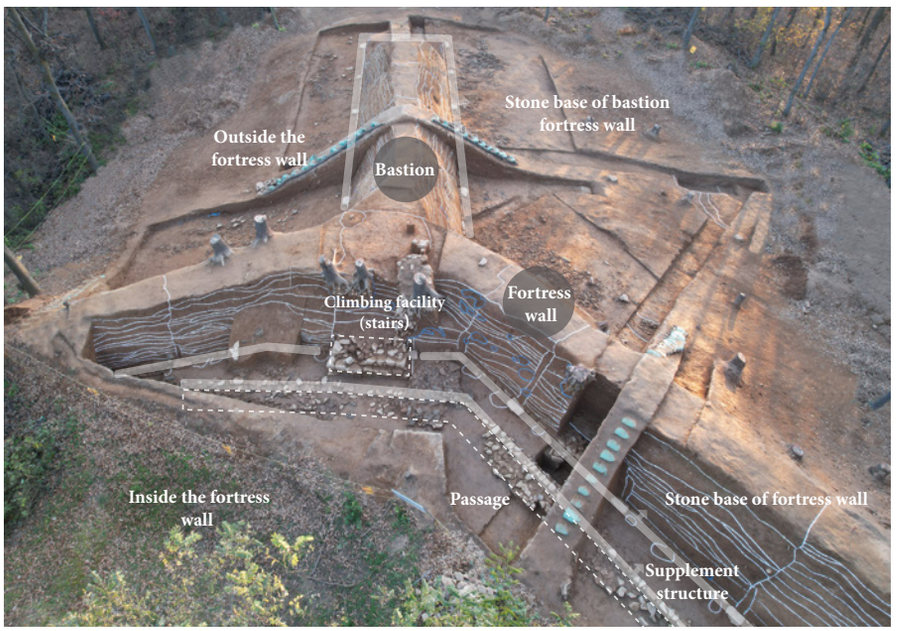
The Jungseong Fortress is the only castle site from the Koryeo Dynasty (918-1392) in South Korea. It is one of the three fortress walls built when the Koryeo Dyanstay transferred its capital to Ganghwa during the invasion by the Mongol Empire. The Jungseong Fortress is the middle wall as 'Jung' means middle in Korean. The earthen fortifications surrounds the capital Ganghwa in the shape of "⊂" and the currently found fortress walls stretch up to 11.39 kilometers. The fortress is preserved in its original state the most among castle walls built when Ganghwa was the Koryeo capital from the 19th year of King Gojong of Koryeo (1232) to the 11th year of King Wonjong (1270). According to Koryeo history, the circumference of the Jungseong Fortress was 2,960 kan (traditional Korean unit of measurement in architecture, which is about two meters) and had 17 large and small gates. Chiseong refers to bastion, or a protruding walled terrace of the fortress wall, facilitating defense troops against portion of the wall projecting outward to form a walled terrace, facilitating defense for the fortress.

The newly discovered bastion is 19 meters long, 4.5-4.7 meters wide and remaining height of 1.3-2.6 meters. The institute said, "This is the biggest bastion from the Koryeo era discovered so far. The bastion is estimated to manage the traffic connecting the inside and outside of the castle and protected the gate."

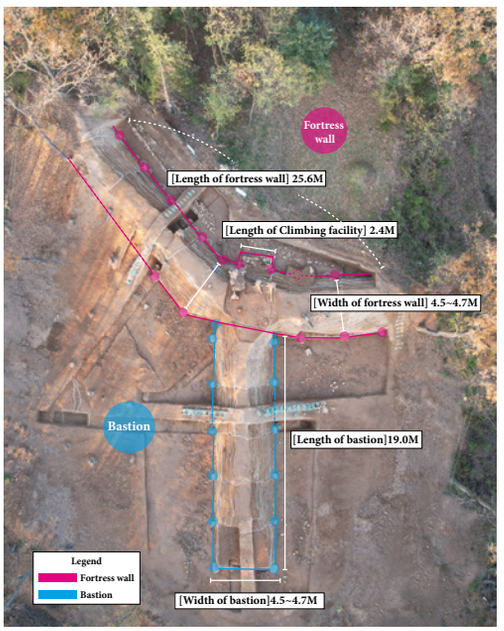
The institute found the bastion while investigating into the Daemun Hill area, along the southern walls of the Ganghwa Jungseong. The bastion was founded from near the western ridge of the current Daemun Hil road, where the castle gate is presumed to be located. The walls are installed on the low ridge above 89-91 meters sea level, alongside the peak and the eastern slope, and the large bastion produces from the wall.

The bastion was built with Panchuk (rammed earth) technique, in which rams earth and sand into place between flat panels, the same way as the main fortress walls were built. On a clay structure, wooden columns and panels make a formwork and putting different types of soil, sand and clay into the frame and stamping them down hard to strengthen. Around the bastion, a variety of artifacts were unearthed including Giwa (roof tiles), a Munhwakseok (rock holding the gate) and cornerstones.

The Ganghwa National Research Institute of Cultural Heritage said the discovery is a meaningful achievement in speculating the structure and operation method of the fortress.



❶ A view of inside of the fortress wall



❷ A map of the third excavation of the Jungseong Fortress on Ganghwa Island

NRICH Hosts Ceremony Commemorating Cooperation with Korean Archaeological Society

The NRICH established a space for cooperation with the Korean Archaeological Society in the institute to nurture the next generation of Korean archaeologists and boost research exchanges and held a signboard hanging ceremony at the Archeology Center of the NRICH on December 28, 2021.

The space will be used for discussing cooperative projects and joint research between the two organizations. In 2021, the two institutions together have offered a summer camp for 40 students from 15 universities to train professionals in buried cultural property.

The students went through field training at seven excavation sites including Wolseong in Gyeongju; Archaeological Site in Wanggung-ri, Iksan; Archaeological Site in Bonghwang-dong, Gimhae; and Earthen Fortification in Pungnap-dong, Seoul. The two institutions will develop more joint programs to train future professionals in studying, managing, conserving and utilizing buried cultural assets.

This ceremony provided a foundation for a smooth cooperation system between academia, institute and government through systematic support from the NRICH, the Korean archaeological circle and the Cultural Heritage Administration.

At the board hanging ceremony, a signboard wishing for "yusiyujing" (where there is a beginning, there is an end) was unveiled, which refers to carrying something from beginning through the end with fruitful results. The president of the Korean Archaeological Society also awarded plaques of appreciation to the Cultural Heritage Administrator and the NRICH Director General in appreciation of their efforts in raising the status and social role of archaeology.

NRICH Unveils Video of Excavations in Russia

On February 22, the NRICH announced the unveiling of a new video of the institute's overseas excavation project commemorating the change of the institute's Korean official name from "gungnim munhwajae yeonguso" to "gungnim munhwajae yeonguwon," promoting the status of the institute. The video "Beginning of Overseas Excavation, Suchu Island in Russia and NRICH," co-produced with the Institute of Korean Archaeology and Ancient History (IKAA) at Kyung Hee University to introduce the NRICH's achievements overseas to the public, was released on the NRICH's YouTube channel on February 25.

The NRICH and the IKAA signed an agreement on research exchange in June 2021 and have been cooperating on Northern Culture research and training professionals in archaeology. As part of the joint effort, the NRICH will release a series of videos on its overseas excavation projects, beginning with a Korea-Russia joint research in 1999. The first in the series is the NRICH's first project abroad, the excavation and joint academic research on Suchu Island and the Bulochka Site in Russia. The video is in a talk show format, featuring researchers who took part in the excavations in Russia. Four experts who carried out the project spoke of their experience of visiting Russia with difficulties in communication from the beginning to their achievements in understanding the exchanges between ancient cultures of Eurasia. After the premiere on February 25, five more videos will be released in April, June, August, October and December of 2022. A trilogy on Suchu Island is planned in the first half of the year, with the second and third episodes focusing on the first excavation in Russia and the significance of the Suchu Island excavation now, respectively. A variety of materials and videos related to the overseas excavation will be included.

The NRICH hopes the video series to enhance understanding and interest on overseas archaeological excavations from the public. The institution plans to promote the result of its overseas joint projects in Mongolia and Kazakhstan, highlighting research on the common cultural heritage of humankind through various communication channels for easier understanding of the public.

Youtube QR

Survey Report on Earthquake Damage to Foreign Cultural Heritage and Relevant Countermeasures

NRICH published the report *Earthquake Damage to Foreign Cultural Heritage and Relevant Countermeasures*, which includes survey results on foreign cases of cultural heritage damaged by earthquakes. NRICH conducted various surveys and research in order to devise countermeasures against earthquake damage to cultural heritage. In particular, the institute has been carrying out yearly surveys since 2017 on policies related to follow-up measures, based on damage type, damage status, and reconstruction. Moreover, research has been conducted on the establishment of regulations, focused on countries whose cultural heritage has been heavily affected by earthquakes. NRICH published the survey results this year. This report includes three-year (2017–2019) survey results on damage to cultural heritage and restoration cases in three countries, namely Nepal, Taiwan, and Italy.

Ancient DNA— Ancient Bones Meet DNA

The NRICH published *Ancient DNA*, a book on the analysis process of DNA extracted from human and animal bones from the paleoenvironment excavated from archaeological sites. The institute is continuously improving extraction and analysis methods of DNA found in ancient human bones and sharing genetic information of ancient human bones unearthed in Korea through publications.

The previous books by the NRICH on ancient genetic information were targeted to relevant researchers and experts for academic purpose, but this book is more for the general public with easier explanations with many reference images. The book contains the process from collecting samples from ancient bones in excavation sites to ancient DNA analysis with examples.

Koryeo Metalworks and Silk Road Art

NRICH published three books on research results related to Koryeo Metalworks and Silk Road Art. Understanding the *Koryeo Metalwork 2* features a collection of 130 household crafts from the Koryeo Dynasty.

There have been few remaining relics or documentary records that are seldom available for viewing. The book features small knives, a needle case, makeup brushes, and other miscellaneous personnel objects used by the Koryeo people, in addition to accessories such as bracelets and hairpins. *Encyclopedia of the Silk Road Western Region: Central Asia (Western Turkestan)* is a follow-up study to *Encyclopedia of the Silk Road Eastern Region: Xinjiang of China* published in 2019. This volume covers the western part of the Pamir Plateau—Central Asia and a part of West Asia. The book contains 33 thematic studies on various subjects encompassing history, religion, Buddhist art, and regional crafts where research has been challenged by limited access to the relics and materials. *The Art of Silk Road: New Research Trends and Perspective* contains six different articles on Silk Road art in Central Asia, written by world-renowned scholars from the U.S., Germany, Italy, and Japan.

Conservation Treatment of Irworobongdo from Injeongjeon, Changdeokgung Palace

The Cultural Heritage Conservation Science Center under the NRICH completed the conservation treatment of the Irworobongdo (Painting of the Sun, Moon and Five Peaks) from Injeongjeon Hall, Changdeokgung Palace and published a report containing the process of conservation and related research results. Irworobongdo is a painting symbolizing eternal vitality with a sun, a moon, five peaks with pine trees and rippling waves in a symmetric composition and typically installed in a king's space to emphasize the king's presence and authority during the Joseon Dynasty (1392-1910). The Irworobongdo of Changdeokgung Palace is a four-fold folding screen, originally placed behind the throne in the Injeongjeon Hall, but it was damaged with pigments peeling off and the frame twisted as the main hall of Changdeokgung Palace opened to the general public. At the end of 2015, the folding screen was transferred to the Cultural Heritage Conservation Science Center and went through dismantlement and conservation treatment from 2016 to 2021. The report includes the overall conservation treatment process of Irworobongdo from Injeongjeon Hall, Changdeokgung Palace as well as analysis on materials, art historical research on deformation of the folding screen, historical evidences on janghwang (traditional Korean mounting) and the significance of test answer sheets used as backing paper.

Busosanseong Fortress 1981-2002

The Buyeo National Research Institute of Cultural Heritage published *Busosanseong Fortress 1981-2002*, a book compiling the excavation results of the Busosanseong Fortress in Buyeo, South Chungcheong Province from 1981 to 2002, on the 40th anniversary of the research. The book is a bundle of seven reports on the excavation of Busosanseong Fortress previously released by the NRICH and the Buyeo National Research Institute of Cultural Heritage with photos and drawings newly converted into high-resolution color and digital images. In the book, the ruins of the Baekje era castle are largely divided into the fortress and the sites inside the castle. Fortress ruins include traces of gates and affiliated facilities while building sites, water system and other facilities were found inside the castle. The book also marks the exact site of the protective structure built for the Monument for Liu Renyuan of Tang China, which was destroyed during the Japanese colonial rule and moved to the Buyeo National Museum after Korea's liberation.

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