Training Report
on
Cultural Heritage Protection

The Training Course for Researchers in Charge of Cultural Heritage Protection in Asia and the Pacific 2006 –Vietnam –
6 November – 21 December 2006, Nara

Cultural Heritage Protection Cooperation Office,
Asia/Pacific Cultural Centre for UNESCO (ACCU)

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Preface

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The Cultural Heritage Protection Cooperation Office, Asia/Pacific Cultural Centre for UNESCO (ACCU Nara) was established in 1999 with the cooperation of the Agency for Cultural Affairs, Nara Prefectural Government and the Municipal Government of Nara. Since its establishment, the ACCU Nara Office has worked towards the protection and investigation of cultural properties through training courses, international conferences, public symposia and database production.

Training courses on the investigation and protection of cultural heritage form an important part of our activities. These training courses are of two types: group courses of about one month for some fifteen participants and individual training on particular topics for one or two participants. The present course was the second type and was held in association with the National Research Institute for Cultural Properties. This time we welcomed two specialists from Vietnam.

The participants have been engaging in investigation and preservation of Thang Long Site. Thang Long Site which was discovered at the construction site of the new National Assembly Building in December, 2002, proved to be the archaeological site with magnificent structures; the site had been formed in stratification by accumulated relics of ancient Imperial Palace sites from around the 7th century to the 19th century. The former Prim Minister Koizumi visited Vietnam in 2004 and promised that Japanese government would cooperate to excavate and preserve Thang Long Site. With such a background, we will invite research workers who have been engaging in investigation and preservation of archaeological sites, as a part of Japanese corporation.

Finally, we wish to thank Gango-ji Institute for Research of Cultural Properties for their assistance with this training course.

YAMAMOTO Tadanao
Director
Cultural Heritage Protection Cooperation Office,
Asia/Pacific Cultural Centre for UNESCO (ACCU), Nara

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Ⅰ Introduction

1.General Information

Training Course on Cultural Heritage Protection in Asia and the Pacific 2006

(6 November－21 December 2006, Nara)

1. Organizers

Jointly organized by *Bunkacho* (Agency for Cultural Affairs, Japan); Asia/Pacific Cultural Centre for UNESCO (ACCU); The National Research Institute for Cultural Properties In cooperation with the Ministry of Foreign Affairs of Japan

2. Background

Hanoi, the current capital of the Socialist Republic of Vietnam, has been the centre of politics and culture for a thousand years since the 11th century when the ancient capital Thang Long (Ascending Dragon) was set there. The stores and houses on the streets in old downtown still retain traces of ancient times and the city is blessed with rich heritages. The numbers of the historic sites in the city amount to as many as two thousands.

Among all historic sites, Thang Long Citadel Site which was discovered at the construction site of the new National Assembly Building in December, 2002, proved to be the archaeological site with magnificent structures; the site had been formed in stratification by accumulated relics of ancient Imperial castles sites from around the 7th century to the19th century. The oldest structure remains date back to the period of Chinese dominion and can be identified as Annam *Togofu* (a local agency of the Chinese government which was established to rule the submitted peoples in the surrounding areas from 679 to 939), where Abeno Nakamaro (a Japanese envoy to China in the Tang Dynasty and promoted to be a Chinese government official) served as an administrator.

UNESCO appreciates the historical value of Thang Long Citadel Site which compares favorably with Chan'an of Tang Dynasty or Rome while Vietnamese government is aiming to register the site as the World Heritage. The former Prim Minister Koizumi visited Vietnam in 2004 and promised that Japanese government would cooperate to excavate and preserve Thang Long Citadel Site. With such a background, organizers will invite research workers who have been engaging in investigation and preservation of archaeological sites, as a part of Japanese corporation.

3. Date and Venues

Date: 6 November (Mon.) to 21 December (Thu.), 2006 (46 days)

Venues: Cultural Heritage Protection Cooperation Office, ACCU (ACCU Nara); National Research Institute for Cultural Properties, Nara; National Research Institute for Cultural Properties, Tokyo; Gangoji Institute for Research of Cultural Property etc.

4. Objective of the Training Course

A sequence of the individual training course focused on mainly acquiring the basic knowledge concerning to the conservation science in general, the environmental control for conservation of relics, and necessary techniques on conservational treatment of metallic and wooden objects.

5. Training Curriculum

- Introduction to the conservation science
- Reconstruction of earthenware
- Environmental control for conservation of relics
- Introduction to the conservational treatment of metallic objects and workshop
- Introduction to the conservational treatment of wooden objects and workshop
- Facility tours etc.

6. Participants

<u>Tran Dinh Thanh (Mr)</u>

Ministry of Culture and Information, Department of Cultural Heritage, Division of Relic and Monuments Management, Expert

Date of Birth: 2 October, 1971 (Age 35)

<u>Nguyen Van Anh (Mr)</u>

Vietnamese Academy of Social Sciences, Institute of Archaeology, Historical Archaeology Department, Bachelor of History, Archaeologist

Date of Birth: 6 July, 1979 (Age 27)

7. Process of Invitation

The director-general of Department of Cultural Heritage (Ministry of Culture and Information) and the president of Institute of Archaeology jointly recommended two applicants suitable for the above mentioned invitation programme as participants. Then ACCU Nara Office has determined to accept two applicants as trainees through close examination.

8. Others (Past achievement to accept trainees)

Since 2000 when the above-mentioned invitation programme started, 19 trainees from 10 countries have been accepted. It is the second time to invite trainees from the Socialist Republic of Vietnam since 2003.

9. Certificate

Each trainee will be awarded a certificate upon the completion of the course.

10. Language

The working language of the course will be English and Vietnamese.

11. Expenses

Expenses for participants for the training course shall be borne by ACCU and comprise the following:

(1) Travel expenses:

Participants shall be provided an economy-class return air ticket between the international airport nearest to his/her residence and Kansai International Airport, and domestic transportation costs / to and from the airports and between the training venues in Japan.

(2) Living expenses:

Participants shall be provided a daily subsistence allowance during the training course, beginning from November 6 (Mon.) to December 21 (Thu.) 2006. Arrangements for accommodations will be made by ACCU Nara.

12. Secretariat

YAMAMOTO Tadanao (Mr)
Director

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Asia/Pacific Cultural Centre for UNESCO (ACCU Nara)
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2.Programme Schedule

Day			Lecture	Venue
November	5	Sun.	***Arrival***	
	6	Mon.	Opening Ceremony /Orientation	ACCU
	7	Tue.	A Courtesy Visit: NRICPN / A tour in Nara City	NRICPN
	8	Wed.	Travel to Tokyo	
	9	Thu.	Reconstruction of Earthenware	NRICPT
	10	Fri.	Introduction to the Conservation Science	NRICPT
	11	Sat.		
	12	Sun.		
	13	Mon.	Reconstruction of Earthenware	NRICPT
	14	Tue.	Environmental Control for Conservation of Relics Ⅰ (Temperature / Humidity / Lighting)	NRICPT
	15	Wed.	Environmental Control for Conservation of Relics Ⅱ (Air Pollution / Biological Deterioration)	NRICPT
	16	Thu.	Environmental Control for Conservation of Relics Ⅲ (Management for Prevention)	NRICPT
	17	Fri.	Travel to Nara	
	18	Sat.		
	19	Sun.		
	20	Mon.	Introduction to the Conservational Treatment of Metallic Objects	NRICPN
	21	Tue.	Workshop Ⅰ: Conservational Treatment of Metallic Objects (Observation, Documentation, X-ray radiography)	NRICPN
	22	Wed.	Workshop Ⅰ: Conservational Treatment of Metallic Objects (XRF, Mechanical cleaning)	NRICPN
	23	Thu.		
	24	Fri.	Visit: NRICPN facilities, reconstructed buildings in Nara Palace Site, Nara Palace Site Museum etc.	NRICPN
	25	Sat.		
	26	Sun.		
	27	Mon.	Workshop Ⅱ: Conservational Treatment of Metallic Objects (Mechanical cleaning)	NRICPN
	28	Tue.	Workshop Ⅱ: Conservational Treatment of Metallic Objects (Desalination, Stabilization)	NRICPN
	29	Wed.	Visit: Historic Sites in Asuka region, Archaeological Institute of Kashihara, Nara Pref. etc.	
	30	Thu.	Workshop Ⅲ: Conservational Treatment of Metallic Objects (Consolidation, Reconstruction)	NRICPN

December	1	Fri.	Workshop Ⅲ: Conservational Treatment of Metallic Objects (Storage)	NRICPN
	2	Sat.		
	3	Sun.		
	4	Mon.	Introduction to the Conservational Treatment of Wooden Objects	GIRCP
	5	Tue.	Workshop Ⅰ: Conservational Treatment of Wooden Objects (PEG Impregnation Method)	
	6	Wed.		
	7	Thu.		
	8	Fri.		
	9	Sat.		
	10	Sun.		
	11	Mon.	Workshop Ⅱ: Conservational Treatment of Wooden Objects (Freeze Dry Method)	GIRCP
	12	Tue.		
	13	Wed.		
	14	Thu.	Workshop Ⅲ: Conservational Treatment of Wooden Objects (Higher Alcohol Impregnation Method)	
	15	Fri.		
	16	Sat.		
	17	Sun.		
	18	Mon.	Visit: Historic Sites in Osaka Pref. (Naniwa Palace Site, Osaka Castle etc.)	
	19	Tue.	Visit: Historic Sites in Nara Pref. (Yakushiji Temple, Horyuji Temple etc.)	
	20	Wed.	Visit: Historic Sites in Kyoto City (Kinkakuji Temple, Kiyomizu Temple)	
	21	Thu.	Submission of Final Report / Closing Ceremony	ACCU
	22	Fri.	***Departure***	

NRICPT National Research Institute for Cultural Properties, Tokyo
NRICPN National Research Institute for Cultural Properties, Nara
GIRCP Gangoji Institute for Research of Cultural Property

Ⅱ　Summary of Lectures

Summary of Lectures

November 9 (Thu.)

Lecture: Reconstruction of Earthenware

<Ms Inutake / NRICPT>

- Details of the lectures on earthenware treatment
  ① Generating a treatment record card
  ② Confirmation of relative positions of fragments to be joined
  ③ Photography before treatment
  ④ Reinforcement of breaking surfaces
  ⑤ Joining the fragments
  ⑥ Preparation of resin-earth mixture for repair
  ⑦ Preparation of tentative support for defect filling
  ⑧ Filling the defects with the resin-earth mixture for repair
  ⑨ Trimming
  ⑩ Resin setting
  ⑪ Shape retouching
  ⑫ Color retouching
  ⑬ Photography after treatment
  ⑭ Completing the treatment record card

Courtesy call on Mr Suzuki Norio, Director General of NRICPT

Workshop: earthenware treatment (One piece of Izumi ware)

November 10 (Fri.)

Lecture: Introduction to Conservation Science

<Dr Kuchitsu / NRICPT>

- Analyzing cultural properties- full awareness of "5W1H" is important.
  ① "Why" to analyze?
  The reason for the analysis and what are known by the analysis should be clarified.
  ② "What" to analyze?
  A clear answer to the "Why" question is the premise for this second question.
  ③ "When, Where, Who" to analyze?
  ④ "How" to determine the premise analytical procedures after "5W"questions are answered?
  The minimum necessary sufficient analytical procedures must be chosen according to different situations.

Lecture by Dr Kuchitsu at NRICPT

Lecture by Dr Aoki at NRICPT

November 13 (Mon.)

Lecture: Reconstruction of Earthenware (Materials for Earthenware Treatment) <Dr Aoki / NRICPT>

- A large number of earthenware, roof tiles and other earthen articles have been excavated at the Thang Long site.
- There are various steps of earthenware treatment, including salt removal, reinforcement of brittle bases, adhesion of fragments, and filling defective parts.
- Treatment materials that meet respective purposes must be available. From this viewpoint, the appropriate type of materials and the method of treatment must be chosen.

  - Base-reinforcement materials: acrylic resin, silane resin
  - Adhesive materials for fragments: epoxy resin, acrylic resin, cellulose resin, instantaneous adhesive
  - Filling repair: gypsum, glass fiber, micro-balloon resin

November 14 (Tue.)

Lecture: Environmental Control for Conservation of Relics I <Dr Aoki>

- Lecture on environmental conditions for preserving remains in better condition.
- An introductory lecture on the influence of temperature, humidity and light on the deterioration of remains was followed by drills, data analysis and countermeasures sessions for environment control methods and measurements in the preservation of remains in closed spaces such as archives and exhibition rooms.

November 15 (Wed.)

Lecture: Environmental Control for Conservation of Relics Ⅱ <Dr Aoki >

- Lecture on air pollutants that deteriorate remains and on mechanisms of their deteriorating process.
- Explanation of the effects of temperature, humidity, light, air pollution, organisms and other interacting factors, with a focus on the identification of cause and development of countermeasures in view of cause-effect relationship and features of the damage.

November 16 (Thu.)

Lecture: Environmental Control for Conservation of Relics Ⅲ <Dr Aoki >

- The above-described lectures were integrated into lectures concerning preventive measures. Also discussed were site preservation and maintenance. Specifically, the basic concept, survey methods for soil, and data analysis were described. Finally, a lecture was given on the formulation and implementation of site maintenance plans based on the findings, with mention to actual cases in Japan.

Lecture by Dr Inoue at NRICPN

November 20 (Mon.)

Lecture: Briefing on the NRICPN and the Nara Imperial Palace Site <Dr Inoue / NRICPN>

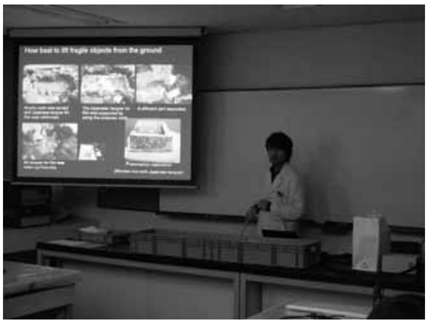
Study tour of the facilities at NRICPN

- Reference Library
- Archaeological Artifacts Storage Facility, etc.

Study tour of the facilities at NRICPN

Lecture: Introduction to the Conservational Treatment of Metal Objects <Dr Wakiya and Ms Tamura /NRICPN>

- Introduction to the conservation process for general artifacts
- Introduction to the flow of work relating to the preservation process for metal artifacts
  - Planning and design of preservation method (what kind of preservation to perform)
  - Primary cleaning
  - Secondary cleaning
  - Strengthening
  - Jointing and combining



Lecture by Dr Wakiya at the laboratory

November 21 (Tue.)

Study Tour: The First Imperial Audience Hall <Dr Inoue and Dr Wakiya>

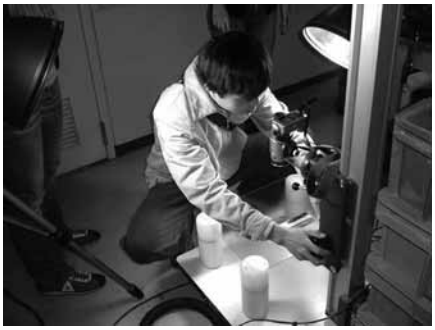
- The restoration site of the First Imperial Hall at the Nara Palace Site
- The seismic isolation structure of the foundation platform
- The timber yard
- The timber processing facility
- The plant for pre-assembling the full-sized timbers etc.

Dr Wakiya explained how to use a ultrasonic polisher.

Workshop: Conservation Treatment for Bronze and Iron Artifacts <Dr Wakiya and Ms Tamura>

- Observation with the naked eye – drawing of a rough sketch on a Record for Conservation Treatment card
- Observation under a binocular microscope to retouch a sketch
  - Degree of rust, staining, contamination, and corrosion
  - A state of any adhering soil
  - The condition of cracks
- Photography of metal objects prior to treatment
  - Checking of horizontality
  - Placing of an artifact, together with a scale and a color chart, on the reflector plate
  - Adjusting of illumination to ensure no shadows of the artifact appear
  - Adjusting of magnification and focus to make the artifact appear as large as possible when photographed
  - Photography of the front and back of the artifact

Drawing a sketch of metal objects



Photography: Adjusting magnification and focus

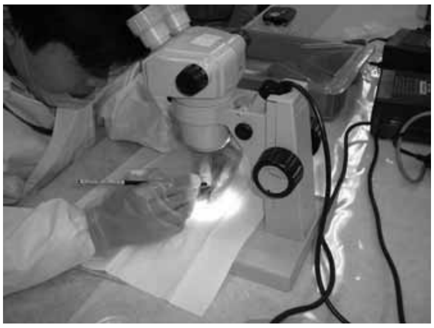
<u>November 22 (Wed.)</u>

<u>November 24 (Fri.)</u>

Workshop: Conservation Treatment for Bronze and Iron Artifacts (continued)

<Dr Wakiya and Ms Tamura>

- Mechanical cleaning
  - Working under a binocular microscope to remove fine grains of sand and grime imbedded in the grooves of surface patterns
  - Tools used for manual cleaning: A brush, bamboo skewer, cotton swab, knife, graver, nipper, grinder, ultrasonic polisher, etc.
  - A precision blasting machine is equipment which removes impurities by using high pressure nitrogen gas to blow alumina powder against the artifact.

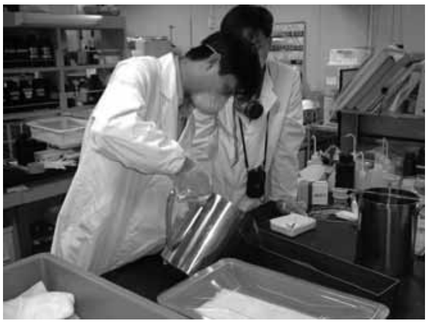


Mechanical cleaning of a bronze artifact with a graver

Mechanical cleaning with precision blasting machine

Stabilization of Bronze Artifacts

- BTA (benzotriazole) treatment
  - Prevention of corrosion caused by chlorine ions
  - Soaking of the artifacts in BTA alcohol solution (2% – 3%) for at least 24 hours



Preparing BTA solution

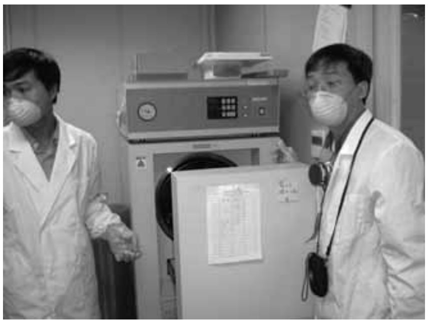
<u>November 27 (Mon.)</u>

Conservation Treatment for Bronze and Iron Artifacts (continued)

<Dr Wakiya and Ms Tamura/ NRICPN>

- Consolidation of bronze artifacts
  - Add acrylic resin (Paraloid B72) to organic solvent (1 part each acetone and toluene) to obtain 5% solution (adjust concentration according to the condition of the artifact).
  - Soak the bronze artifact in the above solution and place it in decompression chamber (0.5 MPa).
  - After decompression, allow to stand for four to five hours, while adjusting pressure according to the bubbles coming out of the artifact.
  - Repeat the decompression and normal pressure alternately two or three times to make the resin permeate the artifact thoroughly.

Organic solvent; toluene and acetone



Equipment of high temperatures and pressures for desalination treatment

Lecture: The Principles of Fluorescence X-ray Analysis

- Irradiation of atoms with X-rays
- Ejection of K-shell electrons, which are the closest to the nucleus
- Transition of L-shell electrons, which are outside the K-shell
- Measurement of electromagnetic waves (fluorescent X-ray) emitted by this transition
- Identification of element

Workshop: Desalination of iron artifacts

Identification of the element by comparing with data sheet

Fluorescence X-ray analysis

Soak the iron artifact in the solution

Iron objects were impregnated in resin solution.

<u>November 28 (Tue.)</u>

Conservation Treatment for Bronze and Iron Artifacts (continued) <Dr Wakiya and Ms Tamura / NRICPN>

- Desalination of iron artifacts
  - Preparation of solution: 0.2% BTA (benzotriazole) and 0.1% borax ($Na_2B_4O_710H_2O$) in distilled water
  - BTA and borax are added for purposes of rust prevention and buffer effect.
  - Soak the iron artifact in the solution and place it in high temperature and high pressure equipment.
  - Allow to stand four hours at 120 degrees Celsius and 1.2 atmospheres.

Lecture: X-ray Photography of Cultural Artifacts

- Overview of electromagnetic waves
- Two characteristics of X-rays
  - Continuous X-ray
  - Characteristic X-ray
- Overview of X-ray photography
  - General outline of X-ray photography equipment
  - Principles of X-ray photography
  - Solutions for geometric un-sharpness

Hands-on Training: Fluorescence X-ray analysis

- Energy Dispersive Micro-Focus X-ray Fluorescence Analyzer
  - Directions for using the analyzer
  - Cautions for use
  - Identification of components using samples

<u>November 29 (Wed.)</u>

Study Tour of the Asuka Historic Sites and the Fujiwara-kyo (Kashihara City, Nara Pref.)

November 30 (Thu.)

Conservation Treatment of Metal Objects (Consolidation and Reconstruction) Lecture: Treatment after Desalination

<Dr Wakiya and Ms Tamura / NRICPN>

NAD-10 (acrylic resin) and B72 (acrylic resin) are present as resin within the dissolved liquid.

There are two types of resin:

- **Thermoplastic resin** melts when heated and solidifies when cooled.
  - This type of resin is used in conservation science because of its reversible and easily soluble nature.
- **Thermosetting resin** once solidified, does not melt again.
  - The most typical one is epoxy resin with high strength.

Lecture: Fluorescence X-ray Analysis

- The objective of this analysis is to identify composition of inorganic artifacts through non-destructive inspection.

Workshop: How to Extract Buried Artifact from the Earth

Hands-on experience with two methods:

- Method #1: Extraction using polyurethane foam.
  - A wide range of applications
  - Sometimes used together with Method #2
- Method #2: Extraction using bandages.
  - The artifact is wrapped in bandages.
  - Doused with water.
  - Allowed to harden.

December 1 (Fri.)

Workshop: Storage after Conservational Treatment

<Dr Wakiya and Ms Tamura / NRICPN>

The artifact is packed in a high gas barrier bag after photographing.

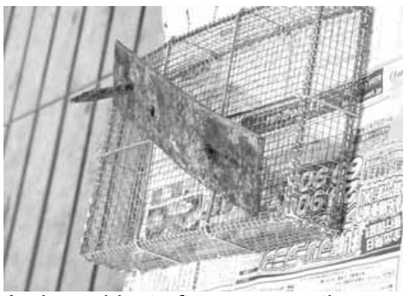
RP System™ (A preservation system used for storage)

- Put an artifact, RP Agent, and O_2 Indicator in the bag.
- Hermetically seal the bag.
- Indicator shows that RP Agent absorbs oxygen and corrosive gasses inside the bag.
- Need to pay attention to any change in temperature.

Composition of the metal artifact was shown on the screen.

Methods#1: Extraction using polyurethane foam

Methods#2: The artifact wrapped in bandages is doused with water.



An iron object after conservation treatment

Having a friendly talk with Rev. Tsujimura at the head office of GIRCP

Observing restoration work at GIRCP

Photographic studio at GIRCP

Weight measurement before treatment of each wooden block

December 4 (Mon.)

Visit: Courtesy visit to Rev. Taizen Tsujimura, Chief Priest of Gangoji Temple

Study tour of the Gangoji Institute for Research of Cultural Property (A head office)

Introduction to the Conservational Treatment of Wooden Objects <Ms Ueda / GIRCP>

Overview of

- The conservation of general artifacts
- The conservational treatment for wooden artifacts
- The advantage and disadvantage to each of the following methods:
  - Sugar alcohol impregnation
  - Higher alcohol treatment
  - Polyethylene glycol (PEG) impregnation

December 5 (Tue.)

Lecture: Conservational Treatment of Wooden Objects <Mr Murata and Mr Fujita / GIRCP>

Lecture: Overview of the flow of work

(1) Preparing of records (notebooks, cards)

- Photography
- Measurement (with vernier calipers)
- Gravimetry

(2) Preservation methods

- PEG impregnation method (20% – 40% – 60% – 80% – 100%): 60 degrees Celsius
- Freeze drying method (PEG 20% – PEG 40%): Room temperature – freeze drying
- Sugar alcohol method (lactitol 40% – 60%): Checking of sugar content using a saccharimeter
- Air drying method

The concentration is raised stepwise. When raising the concentration, records are to be consulted and observations are made for any changes in cracks and shape of the artifact. Then measurement and gravimetry are conducted.

Workshop: Conservational Treatment of Wooden Objects

- Preparation for a record and documentation
  - photographs
  - date
  - dimensions
  - weight
  - treatment methods
- Photography (front and back, diagonal, cross section etc.)
- Washing in water with brushes
- Measurement and gravimetry
- Preparation of impregnating solution (PEG 20% solution; lactitol 40% solution)
- Eight wooden blocks are treated with four different methods

The concentration of impregnating solution and duration of impregnation time differ according to the size, configuration, and state of preservation of the artifact.

Washing before treatment

Eight wooden blocks, ready for conservational treatment

<u>December 6 (Wed.)</u>
<u>December 7 (Thu.)</u>
<u>December 8 (Fri.)</u>

Workshop: Conservational Treatment of Wooden Objects (continued) <Mr Murata and Mr Fujita / GIRCP>

- Impregnation of samples (raising of concentration)
- Measurement and gravimetry
- Observation of the actual process of raising PEG concentration
- Study tour of the storage facility for large artifacts

Preparing solution for PEG impregnation method

<u>December 11 (Wed.)</u>

Identification of Tree Species and Measurement of Water Content <Ms Inoue / GIRCP>

Lecture: Overview of Japanese tree species

- Differences between coniferous and broadleaf trees
- Broadleaf trees fall into three categories according to the distribution of vessels in a cross section.
  - Diffuse-porous wood ---Vessels are distributed uniformly.

Mr Murata showed artifacts impregnated in PEG.

Making thin slices of a wood block for identification of tree species

Explanation of vacuum freeze dryer

- Ring-porous wood ---Large vessels appear only outside of an annual ring.
- Radial porous wood---Vessels are arranged radially.

Hands-on training: Making permanent preparations to identify tree species

- Cutting with a razor to make thin slices of a wood block in three directions
  - a cross section (*koguchi*)
  - a radial section (*masame*)
  - a tangential section (*itame*)
- Placing the slices in petri dishes containing water
- Safranine staining
- Dehydration (replacing water with ethanol, butanol and xylene in sequence)
- Placing the wood specimen on a glass slide and mounting with acrylic resin
- Observing under a microscope, comparing with standard samples, and identifying tree species

Measurement of water content of wood

December 12 (Tue.)

Conservational Treatment with Vacuum Freeze Dryer
<Mr Murata and Mr Fujita / GIRCP>

Air is removed from within, and the artifact is placed in decompression, followed by vacuum. The treatment is designed to bring solid (ice) to gas (water vapor) through sublimation, that is, avoiding the liquid state, so that the artifact itself is not damaged.

December 13 (Wed.)
December 14 (Thu.)

Completion of Conservational Treatment of Wooden Objects <Mr Murata and Mr Fujita / GIRCP>

- PEG impregnation: Remove artifacts from 100% solution and wipe out the solution. Wash off PEG on the surface with ethyl alcohol.

- Sugar alcohol method: Wash off sugar around the wood specimen using hot water. Allow to air dry.
- Freeze drying method: Wipe off the white PEG crystals on the surface while applying hot air from a blow dryer.

After measurement and gravimetry, participants compared the four methods of conservation.

Washing off sugar on the surface in hot water

On-site training in the Operations Section for making the pedestal upon which to display the artifact once conservation treatment is complete <Mr Yamada / GIRCP>

- The area around the treated artifact is filled with urethane foam (the artifact is inverted so that the bottom faces up).
- Aluminum foil or other such material is used to fill any missing spaces on the bottom of the artifact. Tin foil is then used to cover the bottom.
- One percent coagulant is added to silicone resin, then mixed and poured on over the tin foil.
- The silicone resin is allowed to stand 24 hours to solidify.
- The pedestal is completed and the artifact is taken out.

The artifact was taken out from urethane foam.

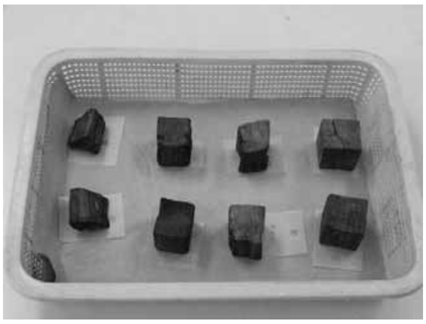
<u>December 15 (Fri.)</u>

Lecture: Summary of Conservational Treatment of Wooden Objects <Ms Ueda / GIRCP>

<u>Air drying method</u>

The wooden objects shrunk considerably, but the degree of shrinkage differed according to the state of the wood. Shrinkage was most prominent in the tangential direction, followed by the radial direction. Shrinkage was least prominent in the direction of the grain. The degree of shrinkage in the tangential direction varied according to the state of deterioration of the wood.

Ms Ueda summed up the results of four different methods.



The results: air drying, PEG, sugar alcohol, and freeze drying (from left to right)

Comparison of three methods

- The wooden sample treated with the vacuum freeze drying method was the lightest among others.
- The PEG impregnation method resulted in considerable deformation of the artifact. In terms of shape deformation, the following methods were superior in descending order: vacuum freeze drying, sugar alcohol, and PEG impregnation.
- We can conclude that the PEG impregnation method is not suitable for the wooden sample this time under consideration of the results.
- We had several restrictions on time to complete the treatment in two weeks. It is necessary to review the conditions such as the duration of time and concentration of the solution for each treatment. For instance, wood blocks would undergo less shrinkage if the concentration was raised in smaller steps. It is also important to take enough time in carrying out the treatment.
- The major difference between PEG and sugar alcohol is the difference in molecular weight. Both methods are relatively easy for anyone to perform, while there is a need to adjust the concentration of impregnating solution, and temperature control.
- The vacuum freeze drying method is also frequently used in Japan.

Lecture: Conservation of textiles <Ms Ueda / GIRCP>

- Cloth has a relatively small degree of shrinkage. Cloth is generally stored in a properly prepared storage environment, without any special reinforcement with chemicals.
- The important thing is to first observe what kind of state the cloth is in.
- The most difficult thing is to maintain the color of the cloth. Oxidation causes discoloration. If a cloth is dug out and kept in an oxygen-free environment, the color of the cloth can be reproduced. Contrary to expectations, reproduction of color on cloth is more difficult than on wood.

December 18(Mon.)

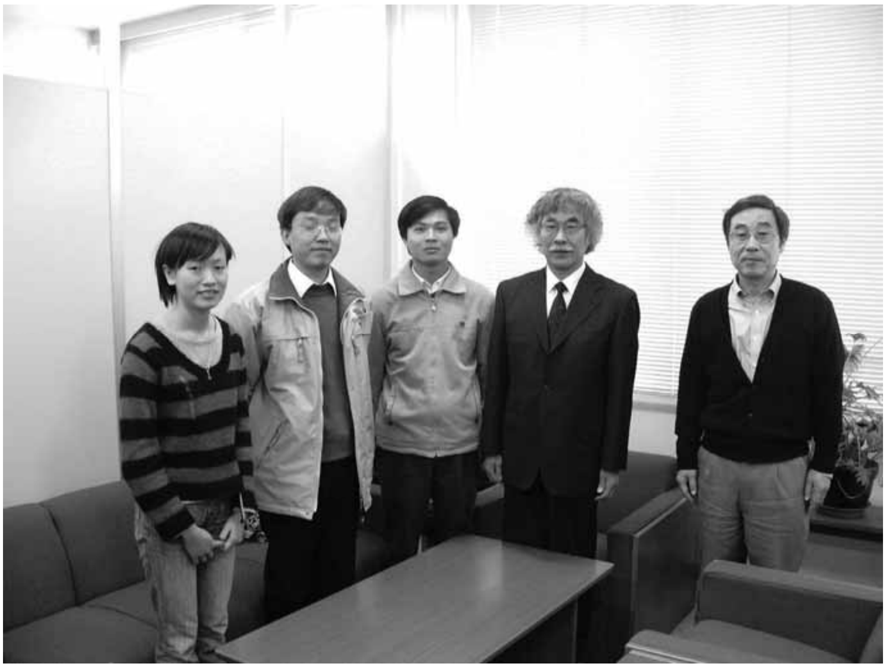
Study tour: Osaka Museum of History, Naniwanomiya Palace Sites, and Osaka Castle

December 19(Tue.)

Study tour: Yakushiji Temple and Horyuji Temple

December 20(Tue.)

Study tour: Kyoto, Kinkakuji Temple, Ryoanji Temple and Kiyomizu Temple



Closing ceremony: Mr Tran Dinh Thanh and Mr Nguyen Van Anh at ACCU Nara office

Ⅲ　Participants' Country Reports

Country Report

Tran Dinh Thanh
Architect, Expert
Department of Cultural Heritage
Ministry of Information and Culture, Vietnam

Conservation of metallic and wooden objects in Vietnam

In Vietnam we have an average of 40 archeological excavations per year. Excavations usually extend from $100m^2$ to $200m^2$ and must be approved by the Vietnam ministry of culture and information and managed and inspected by the local department of culture and information, where the excavation is taking place.

According to the Vietnam Law on Cultural heritage, the individual who manages the archeological excavation should have graduated from a specific university and had at least 3 years of experience in excavations. All excavations should strictly follow the "Regulations governing archeological explorations and excavations" issued by the Ministry of Culture and Information. Six months after finishing the excavation the individual who managed the excavation should send a report, in which they summarize the results of the excavation to the Ministry of Culture and Information. And after two years they should send a scientific report about the results of the excavation to the Ministry of Culture and Information and the local department of culture and information, where the excavation took place.

Vietnam laws on cultural heritage also stipulate that the organization in charge of the excavation should have measures in place to protect objects as well as the excavation site during the excavation period. The person in charge of the excavation should be responsible for the classification of the excavated objects as well as proposing measures to conserve those objects to the Ministry of Culture and Information and Local Department of Culture and Information for their own research and decisions concerning the objects.

According to the Vietnam Laws on Cultural Heritage all objects found during the excavation period should be handed over to the Local Department of Culture and Information for their overall management. The Ministry of Culture and Information will have the final decision whether or not to allow local or central museums to manage, to protect or to display.

After the Laws on Cultural heritage are implemented the whole archeological excavation from the preparation period to finishing period is executed according the set regulations and laws. However, due to the varying conditions of the found objects and the fact that conventional treatment of objects found in the excavation is not sufficient, most objects found in the excavation were just numbered and put into storage. Some wooden objects were soaked in water before being sent to the local museums for their maintenance. Most metallic objects are numbered and wait to be transferred to local museums. After finishing the excavation all objects should be transferred to local museums where the objects will be cleaned manually (cleaned, washed in normal water), after that they will be numbered and transferred to their stores. Normally the objects will be divided to organic and inorganic groups for protection. Wooden, paper, cloth objects will be put in the same store; metallic objects will be protected in another store.

In most stores of Vietnam museums in which organic objects are protected there is temperature and humidity control by A/C. However, because most wooden and metallic objects had not been properly treated before being transferred to the store, many wooden objects have changed form and some metallic objects have rusted.

Museum officers still do not have any methods to protect wooden objects. They do clean and clear the surfaces of metallic objects periodically, but industrial oil and grease is used to clean in the surfaces of some special metallic objects to limit the rusting of the objects.

Objects found in excavations are still continuing to be downgraded although they underwent maintenance in the stores of the museums. One of the main reasons for this is that the archeological objects are not treated and maintained correctly because we do not have any suitable scientific method for each specific object.

Some archeological objects, found at archeological sites are not treated before transferring to the store due to some following reasons:

In Vietnam there are no organizations, institutes or universities where people can be trained in the conservation of archeological objects. In the Vietnam Ministry of Culture and Information there are three main institutes: Institute of Fine Arts Research, Institute of Culture and Information, Institute of Conservation of Relics. However, the institutes have no department that undertakes research and development into conservation of archeological objects that museums can implement. In Hanoi University of Culture there is also a museum and a conservation faculty. Every year there are many students who graduate in this field. However, they do not study conservation of objects in their training programme. Owing to the current lack of the theory and scientific research into the treatment of excavated objects, there is no organization or office that has the responsibility to organize and treat excavated objects.

According to the experience of developed countries, for the treatment of just one archeological object they require staff from many fields, such as archeological excavation, physical analysis of materials and evaluation, and chemists advising in the use of chemicals to treat and conserve the object. In addition, they have access to many refined and new equipment and systems, and expensive chemicals. Therefore, the budget for the conservation of objects is very large and a great deal of time is spent on determining the best conservation method. Money is the true obstacle for us as Vietnam is still a developing country and the economy faces many difficulties.

As well as the economic difficulties we have another problem. That is the museums. Most of them were built a long time ago; therefore their storage areas are too old, undeveloped and downgraded. If we continue to use such stores to protect and conserve the objects, we are certain that the objects will continue to be downgraded and all the conservation and treatment works will have been in vain.

That is the reality of the conservation and treatment of excavation objects in Vietnam. We hope that in the future we can acquire and inherit the ability to conserve and treat excavation objects from an advanced country, where they have many experiences in this field, including Japan. With assistance from experts, equipment and knowledge of the latest methods to treat objects from Japan, we will have a chance to put into practice in Vietnam the latest conservation methods.

Country Report

Nguyen Van Anh
Thang Long imperial citadel Project -Vietnam Institute of Archaeology
Vietnamese Academy of Social Sciences (VASS)

Problem and Solution of Thang Long Imperial Citadel Conservation

In 2002 the Vietnam government had a plan to build a new building at Ba Dinh political center at the site of Thang Long Forbidden City. Historians and archaeologists requested the Vietnam government to excavate this site before building.

With the permit of the Vietnam government, in October 2002, the Vietnamese Academy of Social Sciences began excavations under the Institute of Archaeology. The excavation resulted in the discovery of thousands of objects and many architectural relics of the Dai La period to the Nguyen dynasty. These discoveries are evidence that prove that the excavated area is the center of Thang Long Imperial Citadel from the eleventh century to the eighteenth century under the Ly, Tran, and Le dynasty.

Because of the special value of this site, the Vietnam government permitted the Institute of Archaeology to continue to excavate and research, and also requested a long-term protection plan of the site. However, the Thang Long site is a large and complicated site, there are numerous culture layers, which cover or cut each other.

Sadly Vietnam lacks experts on urban archaeology and experience in conservation preservation of archaeological sites. Therefore, conservation of the Thang Long site is very difficult.

Preservation and conservation of Thang Long site includes the two sections of site and objects.

I. Actual state of conservation of Thang Long site

I.1. Conservation of site

Thang Long site is large site and has many culture layers, the deepest being about 4 meters and the shallowest layer about 1meter. The different depth of layers and climate condition imposes difficulties for the conservation of the Thang Long site.

The Thang Long site is located in a tropical area, experiencing strong monsoons, a considerable amount of sunny days, and with a high rate of rainfall and humidity, not so advantageous for a comfortable working atmosphere; additionally the underground water level is too variable to control properly.

To control the water in the site we built a shelter and a drainage system. The roof of the shelter is plastic sheeting so it prevents rain but it cannot protect against the heat of the sun and in fact increases the temperature. On a sunny day, the temperature in the shelter is usually higher than the outside by 2 or 3 degrees.

Fig. 1 Shelter of Thang Long site

The temperature induces an evaporation process and the water driven to the surface of the site splits open many artifacts. Another difficulty is the development of fungus and bacteria, especially during the rainy season.

I.2. Preservation and Conservation of objects

The excavation found millions of objects, according to artifact, we classified the objects into three groups: earthenware, metalwork, and wood.

Earthenware includes ceramic objects, terracotta objects and stoneware which are utensils such as bows, dishes, vessels, and others... and components of buildings. This group is classified and kept in temporary store, some objects have been restored using 502 resin.

Metal objects include coins, utensils, and weapons. Coins and utensils are made of bronze or gold, weapons are bronze or iron. Coins have been preserved and conserved using B72, all carried out by hand without the support of a machine. After treatment, they are kept in a dry cabin. However, most of them have not been treated yet.

Wooden objects mainly are building pillars or components of building. Most of them are soaked in water without preservation chemical so now decay is a problem. Some pillars are covered by jute bag to keep them wet. But now they are drying out and changing form.

Fig.2 Head of dragon decorated on the roof of building

Fig.3 Head of phoenix

II. Solution for preservation and conservation Thang Long site

All preservation and conservation methods applied at Thang Long are primary methods. We have not enough human resources, technical ability or finance to achieve much.

To better preserve and conserve the Thang Long site we have to train conservationists. So this training course on preservation and conservation of cultural heritage is a good opportunity to gain knowledge of cultural heritage preservation and conservation science and exchange experiences in the treatment, preservation and reconstruction of archaeological objects.

Ⅳ Lecturer Paper

Conservation Techniques for Excavated Cultural Properties 4
Conservation Techniques for Waterlogged Woods
KAWAMOTO Kozo

Conservation Techniques for Excavated Cultural Properties 4

Conservation Techniques for Waterlogged Woods

Kozo Kawamoto

Numerous degraded and waterlogged wood products are excavated from ruins in many parts of Japan. If these products are allowed to dry naturally, they shrink significantly and deform to the extent that their original forms cannot be visualized, making them unrestorable. The water absorbed by wood products therefore needs to be replaced by other substances which are stable in the air by conservation treatment. Conservation techniques for excavated wood products were first developed in the mid-19th century in northern Europe, and since then a wide range of treatment techniques have been developed. In Japan, conservation treatment based on these techniques was first practically used about 30 years ago, but many modifications have been made to the techniques to fit the local climate. New treatment techniques are also increasingly being applied. We will need to combine technology in an even broader range of fields in the future.

Keywords: excavated wood product, conservation treatment, substitution, natural drying, shrinking, deformation

1. What is excavated wood?

In general, wood is a material which readily decomposes; however, numerous wood products used over several thousands of years ago are excavated from all parts of Japan. Many of these products have retained their shape until excavation because they were buried in a wet, low-oxygen environment where the activity of aerobic microbes that decompose wood tissues is suppressed. These woods excavated in a water-saturated state are called waterlogged woods. In Japan, excavated woods are often termed waterlogged woods.

Wood products which have fortunately retained their original forms at the time of excavation are also degraded at different rates. As wood products degrade, they lose their cellulose and hemicellulose. This weakens the cell walls, reducing the relic's physical strength and increasing moisture content.

The percentage of moisture content is often used as an index for identifying the degree of degradation of excavated woods. Moisture content is calculated as follows. [1)]

$M = (W_m - W_d)/W_d \times 100$ (1)

M: Moisture content (%),

W_m: Moisture weight (g), and

W_d: Bone-dry weight (g).

Our experience shows that the practical specific gravities of woods are almost the same for all tree species, and are determined as a (a ≒ 1.47). Formula (1) will then be:

$M = \{(a - 1)/a \times (W_a/W_w)-1\} \times 100$ (2)

W_a: Weight of specimen in the air

W_w: Weight of specimen in water.

Accordingly, the degree of degradation of each excavated wood is easily identifiable by measuring its weight.

The moisture content of green timbers is 100 to 200 %, and they are dried to 15 to 30% for use as building materials. In contrast, the moisture content of excavated woods reaches several hundred to several thousand percent, making them extremely fragile and subject to finger dents if held in the hand. Many of them can easily be crushed in the hand. They may even collapse like jelly.

2. Degradation of wood

To conserve excavated woods, we must first be aware of the characteristics of wood degradation. [2)]

2.1 Conifers and broad-leaved trees

Trees can be classified into conifers and broad-leaved trees. In broad-leaved trees, which are more evolved than conifers, the cells are complicatedly differentiated. They have vessels and diverse ray tissues which are not seen in conifers.

In excavated wood, relics made of broad-leaved wood are more often degraded (and show a higher moisture content) than those of conifer wood, and they are more likely to deform or shrink during dehydration in conservation treatment. Since their tissues are more complicated, degradation is not uniform, making it difficult to predict how they will deform.

2.2 Xylem, bark, heartwood, and sapwood

A tree trunk consists of the xylem and the bark surrounding it. The boundary layer between the xylem and the bark is called the vascular cambium layer, which is a layer of meristematic tissue. The center of the xylem is heartwood, and the portion around heartwood is called the sapwood. Heartwood cells are dead. In conservation treatment, phenols in heartwood, blocked tracheids and bordered pits, and tylose in the vessels hinder the penetration of treatment agents.

2.3 Early wood and late wood

Trees in regions with seasonal changes form concentric growth rings. The wood portion formed in spring is called early wood, and the portion formed from summer to autumn is called late wood.

In excavated wood, early-wood portions, where cells are less dense and soft, are often more degraded than late-wood portions.

2.4 End-grain face, straight-grain face and cross-grain face; grain direction, radial direction, and tangential direction

Wood has an anisotropic structure. The wood face when a tree is cut perpendicular to the tree axis is called the end-grain face. The cross-section when a tree is cut vertically along the tree core is called the straight-grain face, and a vertical cross-section parallel to the annual rings is a cross-grain face. The direction perpendicular to the end-grain face is the grain direction, the direction perpendicular to the annual ring is the radial direction, and a direction at a tangent to the annual ring is termed a tangential direction. Agents quickly penetrate in the grain direction, dozens of times faster than in the radial or tangential directions.

Shrinkage of green timber on drying is 1:12.5:25 in the grain direction: radial direction: tangential direction. The degree of degradation of excavated wood is roughly proportional to their moisture content.

2.5 Chemical composition

Cellulose, hemicellulose, and lignin, which are the major components of the tree, account for about 95%, and form the cell walls. The remaining 5% is extracts. The percentage of the major three components, although they differ according to tree species, is roughly 50%, 15%, and 30%, respectively, in conifers; and roughly 50%, 25%, and 20%, respectively, in broad-leaved trees.

Cellulose is made of about 10,000 pieces of glucose bound linearly. Cellulose fibers aligned regularly and bundled have strong tensile strength and resistance to solvents. Hemicellulose is made of several types of polysaccharides with a polymerization number of 100 to 200. Lignin is a hydrophobic high polymer created by dehydrating and polymerizing phenylpropane. Most lignin is present between the wood cells, where it acts to adhere the cells together. Lignin is less decomposed by microorganisms such as wood-destroying fungi. Its extracts include terpenes and tannins.

Taking as an example an excavated red oak (broad-leaved tree) 40 cm in diameter from the Kofun (tumulus) period (around AD 250 to 538), the percentage of the above major components was roughly 32%, 12%, and 46% in the heartwood; and 2%, 3%, and 81% in the sapwood.

3. The importance of conservation treatment

Excavated wood needs to be stored in a soaked state. If moisture decreases, wood shrinks roughly in proportion to its moisture content. However, since the moisture content of wood differs according to portions of the wood, it shrinks unevenly. As a result, the excavated wood deforms to the extent that its original form cannot be visualized.

For example, let's say a log which may have been used as a pile is excavated; the heartwood of this log has a low moisture content because it is less degraded than the outer layers. The sapwood, however, of this log is highly degraded, and its moisture content is high. If this excavated log is allowed to dry naturally, the sapwood shrinks significantly, causing major radial cracks.

Once excavated wood products have become deformed by natural drying, it is almost impossible to restore them to their original forms. In fact, excavated wood products used to be preserved in water or formalin, or were allowed to dry naturally in Japan before conservation treatment of excavated wood products started in the early 1970s. Relics made of conifer wood more or less retained their original forms after natural drying in many cases, but broad-leaved wooden items have significantly shrunk and deformed. Even if they were preserved in water or formalin, degradation was unavoidable.

There are numerous museums and resource centers throughout Japan that provide opportunities, through cultural assets, to learn how our ancestors lived and thought, and how they are connected to us today.

To exhibit excavated wood products in these museums and resource centers, they must retain their forms in the air. If excavated waterlogged wood products are left in the air, however, their moisture content evaporates and the wood products significantly shrink and deform. The most important point in conservation treatment is to substitute moisture in excavated wood products with other substances that are stable in the air so that wood products are supported from inside to avoid deformation of wood tissues.

Even with the current techniques, a few percent change in dimensions before and after the treatment is still unavoidable.

4. Practical conservation treatment of excavated wood products

Many relics are found in excavation research after sites have been revealed during public works carried out by local governments. In general, excavation research is conducted by each local government's Board of Education or Archeological Center. Some local governments consign excavated wood products to the Gangoji Cultural Properties Research Institute for conservation treatment, after which they are returned for exhibition and preservation at museums and resource centers throughout Japan.

4.1 Examination before treatment

When an excavated wood product is brought in to our Institute, we first take photos of it and draw a restored image from conservation scientific and the archeological viewpoint with reference to the excavated conditions so as to record the dimensions and degradation of each wooden part, and cutting pattern. We also identify the tree species, analyze the pigments applied to the relic's surface, observe any lacquer film structure, and so on.

4.2 Examination of treatment policy

Treatment policy, such as treatment techniques (impregnating agent, substitution, impregnation period) and restoration techniques, is determined based on tree species (in particular, some species of broad-leaved woods are likely to shrink or deform if subjected to conservation treatment), degree of degradation, cutting of timber (woods containing core portions often suffer so-called orange-like cracks), dimensions, (thickness in particular), surface condition (degree of remaining traces of artificial work), etc.

4.3 Cleaning

Wood products are washed with water using brushes and bamboo skewers so as to remove as much mud and sand as possible without damaging them. When iron content is deposited, the relic is immersed in a chelating solution (ethylene diamine tetra-acetic acid, 3Na) for removal.

4.4 Agent substitution and impregnation

At Gangoji Cultural Properties Research Institute, the most appropriate technique is selected for treatment from five techniques: polyethylene glycol impregnation, alcohol xylene resin, freeze-drying, fatty acid ester, and sugar alcohol impregnation. (Details follow.)

4.5 Restoration

Based on research conducted before treatment, broken parts are attached with adhesive (in general, cyanoacrylate adhesive is used if there is no gap between the parts, and epoxy resin is used if it is ambiguous), and cracked portions are filled (epoxy adhesive mixed with glass microballoons). After curing, the surface is ground (to give in an authentic rough surface, etc.), and colored with acrylic paints. Ideally, restored parts should not be recognizable if seen from a distance but should be clearly distinguishable under close examination.

4.6 Research after treatment and delivery

Shape, surface condition, color tone, etc., of the relic during excavation or when brought to our Institute are compared with those after treatment to check whether any pieces of information have been lost or added by restoration. Such information is recorded before the relic is returned.

5. Developments in conservation techniques (agent substitution and impregnation techniques) for excavated wood products

Conservation treatment of excavated wood products started in northern Europe, so these are techniques imported to Japan. The original techniques were thus not always appropriate for wood products excavated in Japan, where temperature differences are wide, humidity is high, broad-leaved tree products are often excavated, and the woods excavated have been buried for long periods.

Since the original adoption of imported techniques, new conservation treatment techniques have been developed and practically applied. They have been developed with the aim of shortening the treatment period, and reducing the burden on both people and the environment in addition to solving the problems described above.

At present, there are roughly six techniques used in Japan. Gangoji Cultural Properties Research Institute applies five of them (hereinafter called “current techniques.”)

5.1 The alum technique (aluminum potassium sulfate impregnation technique) [3)]

This conservation treatment was first applied to an excavated wood product in Demark in the 1850s. About 5% water is added to aluminum potassium sulfate, and the mixture is heated to over 90℃ to fully impregnate the wood product with the solution. Then, the wood product is taken out and allowed to cool to room temperature for the alum to solidify within it. A disadvantage of this technique is that aluminum potassium sulfate, which is deliquescent, tends to leak out from the relic. However, the convenience of this method, which does not require the use of any special devices, made it popular in Europe up to the 1960s.

5.2 The alcohol, ether, and resin technique [4])

B. B. Christensen in Denmark developed this technique in the early 1950s, and B. Muhlethaler in Switzerland applied it practically. First, moisture in an excavated wood product is entirely substituted with methanol, which is then substituted with ether. The relic is next dipped in a natural resin solution such as of Dammar gum and rosin, and then lifted out for vacuum drying to remove the solvent. Since organic solvents have low surface tension, wood cells are unlikely to shrink or deform during substitution, impregnation, or drying. The natural resin remaining in the wood solidifies to reinforce and retains the shape of the relic.

5.3 Polyethylene glycol impregnation technique (PEG technique)

Many excavated wood products have been treated with PEG with diverse degrees of polymerization from the early 1960s up to the present. There are various treatment methods.

5.3.1 Spraying with PEG#1500 solution

The warship *Wasa*, which sank in the Gulf of Stockholm in 1628, was salvaged in 1961. The *Wasa* was a ship made of oak, about 70 m long, 17 m wide, and about 20 m high up to the decks. First, PEG#3350 solution was sprayed on it, but its high molecular weight caused dehydration due to osmotic pressure. The solution was then changed to PEG#1500, and treatment using this method continued for about 18 years. At present, the ship is exhibited in the Wasa Museum.

5.3.2 Impregnation in PEG#4000 and gradually increasing the concentration [current technique]

At present, this method is widespread in Japan. PEG#4000 is a water-soluble high polymer (Average molecular weight: 3040), with a melting point of about 55 ˚C. It is a white solid at room temperature.

To take an example of the treatment processes conducted at Gangoji Cultural Properties Research Institute, an excavated wood product is first dipped in a PEG20% solution, and then the concentration is increased to 100% (liquid solution) step by step at intervals of 20%. The impregnation temperature is about 50 to 65 ˚C. The relic, immediately after impregnation, becomes dark to light brown, so the surface is treated to restore the natural texture of the wood. The surface has conventionally been rinsed with trichloroethylene to wash off PEG on the relic's surface. However, it is now more common to rinse the surface with ethanol solution or warm water.

The PEG method is applicable to diverse types of relics, and has many records of success in the past. However, in the case of very fragile relics that have been subject to severe degradation, edges or small protrusions on the relics may be softened by the PEG solution and come off. In addition, PEG in the treatment bath gradually decomposes oxidatively, generating organic acids that lower the pH level. This risks causing corrosion of the treatment bath, even though it is generally made of stainless steel such as SUS 304, 316, or 316L. We have noticed several times that the welded parts, in particular, of the bath corrode rapidly. This is perhaps caused by PEG decomposition due to the concentration of the solution, temperature, and sulfides and chlorides in the relics from their buried environment and changes in the condition of corrosion of stainless steel.

In addition, relics treated with PEG are prone to changes in temperature and humidity. If moisture in the air results in condensation on the relic's surface, the PEG in the relic elutes, and the relic becomes blackened. Under even worse conditions, the PEG inside and on the relic begins to decompose oxidatively, generating organic acids. This may cause brownish discoloration, shrinkage, and peeling of any adhesive used for restoration, or discoloration of paint. Since PEG generates large amounts of foam, even at very high dilutions in water, waste liquid treatment needs careful attention.

The Gangoji Cultural Properties Research Institute has a dozen PEG impregnation baths measuring 2~9 m long and 1~2 m wide. Every year we apply conservation treatment to over 1,000 wood products excavated throughout Japan, ranging from large dugouts to small products such as chopsticks.

A typical large wood product we have treated in the past is the *Ôshura*[5)], a sledge made around the fifth century for transporting heavy objects, excavated in Fujiidera City, Osaka in 1978. It is a wooden sledge with Y-shaped structure fashioned from a single red oak tree. It is about 8.8 m long, 1.8 m wide, and the height at the top part is 0.7 m. The moisture content was low, at 42 to 490%, which is not very different from green timber. Treatment over ten years was completed in 1994, and now it is on permanent exhibition at Osaka Prefecture Chikatsu Asuka Museum. (Figures 1 and 2)

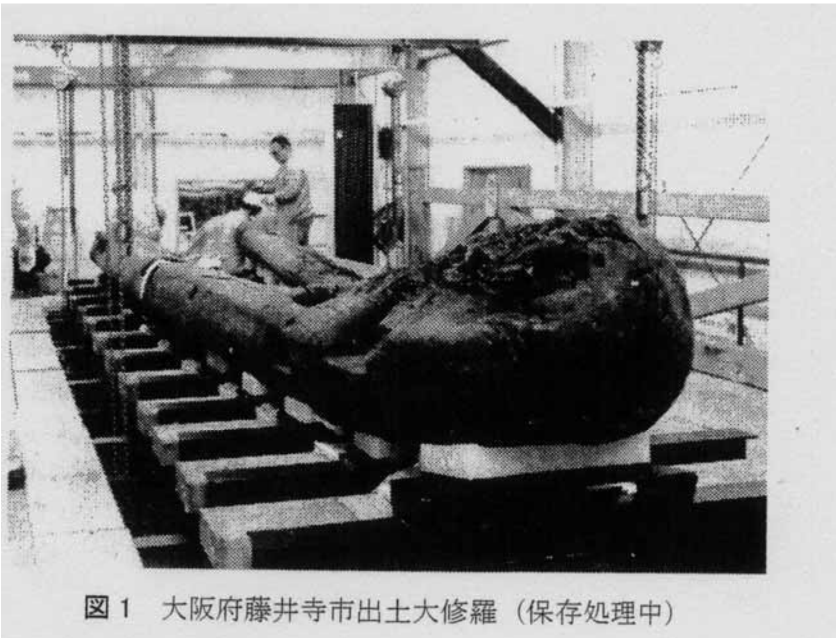


Figure 1 The *Ôshura*, excavated in Fujiidera City, Osaka (during treatment)

The *Ôshura* was treated in a specially built stainless steel bath equipped with a scale. The treatment bath was heated by circulating warm water heated with a boiler. We had intended to follow the processes described previously. However, since we faced the problems of deformation, extending cracks, and a sharp reduction in weight, we partly applied the two-step method described in the following section. Since the treatment bath was corroded, the life of the bath also ended on completing the treatment.

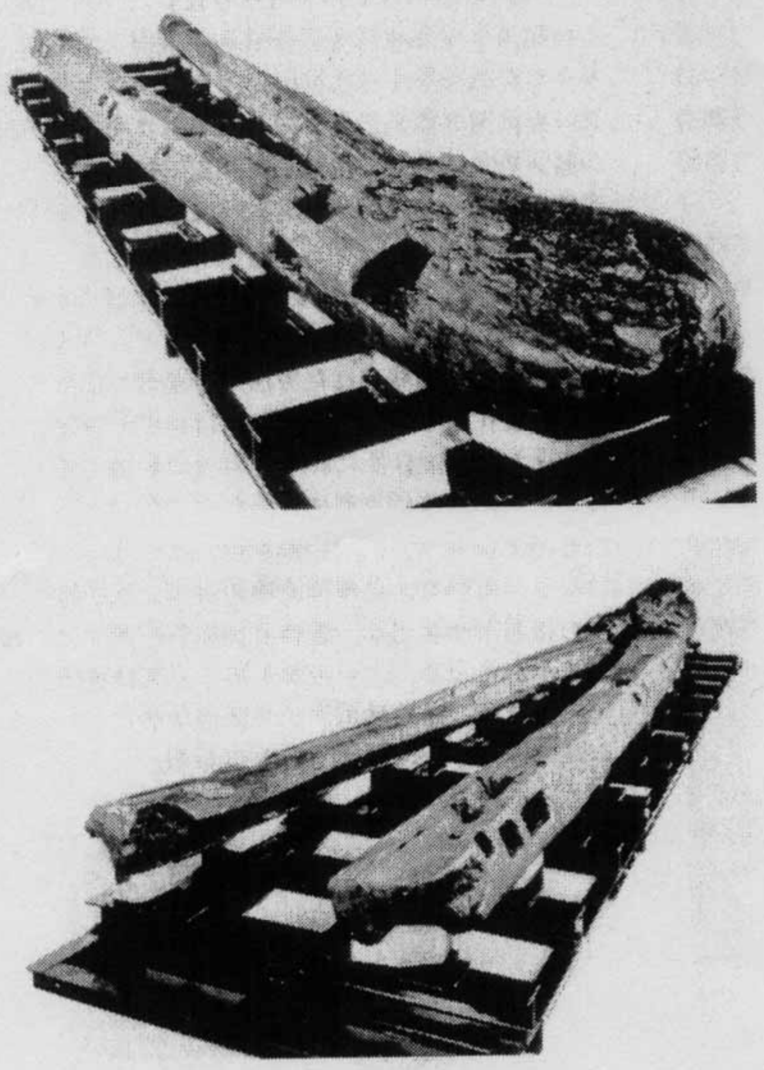


図2　大阪府藤井寺市出土大修羅（保存処理後）
大阪府立近つ飛鳥博物館所蔵・展示

Figure 2 The *Ôshura*, excavated in Fujiidera City, Osaka (after treatment)
In the permanent collection of the Osaka Prefecture Chikatsu Asuka Museum

5.3.3 Impregnation by PEG solution with low molecular weight, followed by impregnation by PEG with high molecular weight (the two-step method)[6]

This method was developed in Germany at the beginning of the 1980s. Low-molecular-weight PEG penetrates into the cells of the excavated wood where high-molecular-weight PEG would probably not reach. This prevents shrinkage during treatment. In addition, the treatment period can be shortened compared to starting by impregnating with the high-molecular-weight PEG solution. In 1986, P. Hoffmann reported a case of impregnating the heartwood part of oak, where degradation is minimal, with PEG#200, and then impregnating the sapwood part, which is more degraded, with PEG#3000. This method has been extensively used in Europe.

5.3.4 Impregnation by cationic surface active agent followed by impregnation by PEG#4000 solution[7])

A wood product made of a broad-leaved wood, such as chestnut, which often deforms and shrinks, is immersed in a solution containing several percent of cationic surface active agent (lauryl amine acetate); it is then gradually immersed in a PEG#4000 solution.

Cationic surface active agents remain in the excavated wood product and soften the cell walls. In addition, this agent lowers surface tension, making it easier for PEG to penetrate into the cells. This is an effective pretreatment method for using the PEG method that broadens its potential range of application.

5.3.5 Others

There are also methods of impregnating PEG solution after impregnating with sugar solution, which will be described later.

5.4 Vacuum freeze-drying technique (FD technique)

This technique was also started in Europe in the early 1950s. There are roughly two methods in this technique.

5.4.1 Tertiary butyl alcohol (t-BuOH) solution of PEG#4000

A relic is immersed in a PEG#4000 t-BuOH solution up to a concentration of 40 to 60% stepwise so as to remove the moisture in the relic. The relic is preliminarily frozen at –40 ˚C, then vacuum freeze-dried.

This method was used for treating a Viking ship that sank in the 11^{th} century in the Roskilde Strait, Denmark. A mixed solvent of t-BuOH and water is also used in some cases.

5.4.2 Use of a PEG#4000 solution [current technique]

The Gangoji Cultural Properties Research Institute impregnates excavated wood products in a PEG#4000 solution up to a concentration of 40 to around 60% stepwise, and cools them down in a freezer to below –40 ˚C as preliminary freezing. The wood products are then vacuum freeze-dried in a lateral cylinder chamber about 50 cm in diameter and 1 m deep in a freeze-drying equipment. Drying conditions are –25 to –30 ˚C in the chamber, a vacuum of 0.05 to 0.1 torr (6.7 – 13 P_8), and a cold-trap temperature of –50 to –60 ˚C. The relic is taken out of the chamber every two to three days to measure its weight. When the weight reduction per day falls to about 1/100 to 1/1000 of the relic's weight, it is regarded as being completely dry. In addition to weight measurement, small cracks perpendicular to the surface grain, curling of the lacquer film, and peeling of pigment are checked to determine whether to continue the drying process.

Over a thousand small items, chiefly of lacquerware, such as lacquer bowls, have been preserved in this way since we started conservation treatment in 1991.

5.5 Acrylamide technique

After impregnating a relic with acrylamide monomer, the relic is immersed in hydrogen peroxide solution so as to polymerize the acrylamide in the relic. This technique was used for numerous small wooden five-story charnel monuments excavated by Professor Masayoshi Mizuno, Nara University, in the precincts of Gangoji Temple. [8)]

If polymerization of acrylamide polymer is insufficient, the relic absorbs moisture from the air, and tar-like water leaches out. This technique also suffers the disadvantages of causing a glossy surface and cracking.

5.6 Alcohol, xylene, and resin technique [current technique][9)]

In 1975, the Gangoji Buddhism Culture Research Institute (currently the Gangoji Cultural Properties Research Institute) developed a modified technique in which the ether used in the above-described alcohol, ether, and resin technique is replaced with xylene, which is easier to handle. Before using amounts of ethanol and xylene that exceed the regulated amount, it is necessary to establish a dangerous substance handling office that conforms to the Fire Defense Law, and handle these dangerous substances in the presence of a person certified to deal with them. Protective tools such as a protective mask, solvent gloves, and protective glasses must be worn.

The relic after treatment becomes strong and flexible. As a result, relics deformed by soil pressure can be easily corrected by applying heat or steam.

Natural resins such as Dammar gum and rosin are suitable for small wood products which are relatively thick, because they have large molecular weight and high viscosity. So far, these substances have been used for treating over a thousand wood strips and bent products.

If the moisture in a relic is not entirely substituted with ethanol and xylene, deformation or shrinkage tends to occur when the relic is immersed in natural resin solution. Accordingly, the average impregnation period of a bent relic is about half a year, including the drying period. After treatment, secular changes in the relic are minor, and its chemical compatibility with epoxy adhesive or cyanoacrylate adhesive is also good. However, the concentration of impregnating resin is set to about 30% (xylene solution) based on the solubility of resin in xylene and the surface condition of the treated relic. This means that 30%

of the airspace in the relic is filled with resin but 70% remains as airspace in the calculation. The absolute physical strength of the relic is thus smaller than after the PEG technique which fills the airspaces almost 100%.

5.7 Higher alcohol technique[10])

Moisture in an excavated wood product is substituted with methanol, and the relic is then immersed in a higher alcohol such as cetyl alcohol (molecular weight: 242, melting point 49 ˚C, a non-water-soluble white solid at normal temperature) or stearyl alcohol (molecular weight: 270, melting point 59 ˚C, a non-water-soluble white solid at normal temperature).

5.8 Fatty acid ester technique [current technique][11])

Since Gangoji Cultural Properties Research Institute developed this technique in 1996, over a thousand relics have been treated. After substituting the moisture in an excavated wood product with ethanol, the wood product is immersed in a 12-hydroxystearic acid methyl ester solution (molecular weight: 314, melting point 54 ˚C, a non-water-soluble white solid at normal temperature) to replace the ethanol.

This technique was developed to treat broad-leaved wood which has high moisture and are prone to deform and shrink when the PEG technique is applied, such as chestnut, Japanese cinnamon, and oak. Since the volume change (apparent density) when an agent solidifies is small in this technique, shrinkage of wood is much smaller than seen with the PEG technique. In addition, most of the information, such as traces on the relic's surface, can be retained. Still more, the time taken to impregnate the relic is about half that of the PEG technique. However, in some cases, crystals of fatty acid esters bead out on the surface of the relic after treatment, whitening its surface. A technique to prevent this from happening is now under study. Since fatty acid esters are relatively insoluble in water, careful attention is needed when treating waste liquid.

図３　石川県能都町真脇遺跡出土彫刻柱
（左，保存処理前；右，保存処理後）
石川県能都町所蔵，真脇遺跡縄文館展示

Figure 3 Engraved pillar excavated from the MawakiRuins, Noto-cho, Ishikawa Prefecture
(Left: Before conservation treatment; Right: After conservation treatment)　Collection in Noto-cho, Ishikawa Prefecture; Exhibited at the Jomon-Mawaki Ruins Museum

We applied this fatty acid ester technique to a carved pillar from the last phase of the First Jomon Period, excavated from the Mawaki Ruin, Noto-cho, Ishikawa Prefecture. It is a cylindrical wooden totem pole, the upper part of which is carved with abstract designs. It is assumed to have been set upright. The upper part is divided into three zones, and carving was found in each zone, but the carving in the middle zone was clearly the most important. Half of each zone on the back was damaged or absent. (Fig. 3)

This pillar is 2.4 m long and 25 to 35 cm in diameter. It is made of chestnut wood, and its moisture content varied significantly, ranging from 390 to 1,680%. Since the pillar is made of chestnut, including heartwood, and its moisture content was not uniform, it would take about 2 to 3 years using the PEG technique. In addition, we thought that there was a risk of shrinkage and deformation if PEG were used. We therefore chose the fatty acid ester technique so that the carvings on the surface would be better retained. It took about a year for the chemical treatment to be completed, with the whole processes taking two years. After the treatment, an exhibition stand was made, and the wooden pillar is now exhibited at Mawaki-Jomon Ruins Museum.

5.9 Sugar impregnation technique

Sugars such as sucrose which have been used for reinforcing and preserving woods for industrial use began to be used as agents for impregnating excavated wood products in the 1980s, mainly in Europe. The advantages of sugars are their faster penetration speed into wood, since their molecular weights are smaller than PEG, their lack of inflammability, and no risk of explosion. However, sugars are hygroscopic, and they also decompose due to the effects of heat and microorganisms. Sugars are therefore not suitable for the Japanese climate.

5.10 Sugar alcohol impregnation technique [current technique][12)]

In 1993, Setsuo Imazu, at the Archeological Institute of Kashihara, reported a technique for impregnating sugar alcohols such as lactytol, instead of sugars.

This technique has since been modified and now trehalose (dihydrate, molecular weight: about 380, white solid), which is a disaccharide comprising pairs of glucose molecules, is added at about 20% to lactytol (monohydrate, molecular weight: about 362, white solid), which is a disaccharide sugar alcohol comprising pairs of galactose and sorbitol molecules, to increase solubility and form a stable crystals.

The excavated wooden product is first immersed in a 40% solution. Since microorganisms feed on tolehalose and a disagreeable smell is generated at room temperature to 40 ˚C, the impregnation temperature is raised to over 60 ˚C, or tolehalose is added after the impregnating concentration exceeds 60%. The wood product is then immersed in a 60% solution. Depending on the condition of the relic, the concentration may be increased to 80 to 90%. The relic is then removed from the impregnation solution and placed in a drying chamber to dry and crystallize the agent. At this point the relic should be heated and dried at about 50 ˚C to avoid generating trihydrate crystals of lactitol, since this crystal is fragile and readily melts depending on the temperature and humidity. To accelerate crystallization, a fine powder of lactitol is applied to the relic's surface.

Unlike PEG, sugar alcohols carry only a small risk of corroding the impregnation bath or having a detrimental effect on adhesives. However, the range of degradation of excavated woods over which this technique is applicable is smaller than the PEG technique. The dynamic viscosity of the wood is also smaller than when impregnating with PEG. In addition, it has a disadvantage in that the wood becomes heavier after treatment since the specific gravity of the agent is large.

Figure 4 Wooden water pipe excavated in Kumamoto City (Before conservation treatment)

Figure 5 Wooden water pipe excavated in Kumamoto City (After conservation treatment)
Collection of Bureau of Waterworks, Kumamoto City

The sugar alcohol technique was applied to a wooden water pipe which belongs to the Bureau of Waterworks in Kumamoto City. This pipe was used in Taisho to early Showa period, the early part of the 20^{th} century, in Kumamoto City and was excavated in 1999. (Figures 4 and 5)

This pipe was made by forming eight convex boards into a cylinder, after which a steel strip was wound spirally around the outside for reinforcement. Asphalt was then applied to fix and waterproof it. The wooden pipe was made of cedar (a conifer), and is about 2 m long and 25 cm in diameter. Since asphalt was applied to the pipe, treatment at normal temperature was suitable. Degradation inside the pipe was worse than expected, and thus the sugar alcohol impregnation technique (lactytol with 20% of tolehalose added, final concentration of solution: 63%, impregnation period: about 4 months) was chosen so that the concentration could be made higher at room temperature. After the treatment, the pipe was dried at 50 ˚C for about a month. Then, a new stainless steel strip was wound around it, and a base was prepared. This wooden pipe is on exhibition at the Water Science Museum.

6. Conclusion

Conservation treatment techniques which have recently been developed make it possible to treat excavated wood products, such as the aforementioned carved pillar, which were not treatable in the past. However, if a relic is made of broad-leaved wood, including heartwood, and has a high moisture content, even the best available treatment is far from ideal. We still face many technical challenges, including insufficient performance of adhesive[13)] in some techniques.

There are many tasks facing us with respect to wood alone. We will need to combine technology in an even broader range of fields to develop conservation treatment techniques that are appropriate for each material of cultural properties, which we predict will become increasingly diversified in the future.

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V Participants' Final Reports

Final Report

Tran Dinh Thanh

Introduction

The Thang Long Citadel Site was discovered in 2002. After four years of excavating this archeological site, many remains and archeological materials with high historical value had been discovered, reflecting the foundation and development since 7th century AD of Thang Long, Hanoi imperial city.

The Vietnamese government had decided to conserve the Thang Long Citadel Site, and at the same time to apply to UNESCO for recognition as world cultural heritage. However, the conservation of the Thang Long Citadel Site has met with many difficulties. Therefore in 2004 the Japanese government agreed to assist the Vietnamese government in cooperating to excavate and conserve the Thang Long Citadel Site. Based on this cooperation the Japanese government has organized a training course for Vietnamese officers in the conservation of archeological materials for the work of conservation of the Thang Long Citadel Site.

I had been selected to attend a "Training Course on Cultural Heritage Protection in Asia-Pacific Region 2006 (individual course)" from 06.11 to 21.12.2006 in Japan with the consent of Vietnamese Ministry of Culture and Information and the Japanese Embassy in Vietnam.

The "Training Course on Cultural Heritage Protection in Asia-Pacific Region 2006 (individual course)", was organized by the Asia-Pacific Cultural Center for UNESCO, ACCU in Nara, Japan, and I am very grateful for the opportunity to attend this training course.

About the Training Course

I am Mr Tran Dinh Thanh, working for the Department of Cultural Heritage, Ministry of Culture and Information, Vietnam. During the two-month study program, I learned the theories of conservation of excavated metal artifacts and conservation techniques for waterlogged woods.

The training course was very well organized by ACCU Nara. It focused on three important subjects:

Subject A: Environmental Control for Conservation Science
Subject B: Conservation Treatment of Metal Objects
Subject B: Conservation Treatment of Wooden Objects

The course in environmental control for conservation science was led by experts from the National Research Institute for Cultural Properties, Tokyo, the course in conservation treatment of metal objects and wooden objects were organized at the National Research Institute for Cultural Properties, Nara and Gangoji Institute for Research of Cultural Property. They are three experienced and prestigious research institutes in the conservation of metal and wooden objects in Japan. The lecturers made efforts to teach us not only in theory, but also in practice, by conducting experiments in the conservation of metal and wooden objects. This method helped me to understand conservation treatments thoroughly.

After the training course I had obtained the basic knowledge about conservation treatments for metal and wooden objects as follows:

1. **Environmental Control for Conservation Science:**

From 9/11/2006 to 16/11/2006 I attended a training course in Environmental Control for Conservation Science, which was organized by the National Research Institute for Cultural Properties, Tokyo. Experts from the institute explained the necessity and importance of environmental control for the conservation of materials and how environmental factors are reflected in long-term conservation.

After discovery, most materials will meet the phenomenon of a change in condition if they did not receive conservation treatment. For example, if you change the humidity and temperature, wooden objects will shrink or swell, and they become cracked and broken. They will change their form. At the same time, microorganisms and dermatophytes will appear and develop, destroying wooden objects. If we use an unsuitable light source to illuminate wooden objects, they will discolor and the degeneracy will be apparent. If, after discovery, metal objects meet with high humidity and oxygen, then rust will appear. Then the metal objects will become eroded and be destroyed. For long-term conservation of metal and wooden objects, after discovery we should conserve them in a stable environment, in which the humidity, temperature and light are controlled.
Wooden objects should be conserved in an environment with humidity of 60%, a temperature of 20^0C, and with white light for illumination. The time of illumination should be as short as possible.

Metal objects should be conserved in an environment with humidity of 40%, and a temperature of 20^0C. We should avoid bringing metal objects from low temperature environments to high temperature environments, as it will produce condensation on the surface of objects.

The institute's experts also introduced us the equipment used in the measurements of temperature, humidity, and level of illumination, and instructed us on how to use this equipment.

2. **Conservation Treatment of Metal Objects**

From 20.11.2006 to 1.12.2006 I attended a training course in the conservation treatment of metal objects, which was organized by the National Research Institute for Cultural Properties, Nara. The institute's experts instructed us directly in the practice of the conservation of bronze and iron objects according to Japanese methods. It will be very useful for me in my work in the future.

Steps to conserve iron objects are the following:

- Take a photograph of the actual state of the object.
- Measure and draw the object (describe exactly the actual state of the object).
- Take photographs with X-rays (XRF and XRD) to find exactly the shape and actual state, level of damage and the contents of the object.
- XRF (X-ray fluorescence spectroscopy) analysis for glass objects.
- XRD (X-ray diffraction) analysis for metal and glass objects.
- Clean the object by hand, with a machine and with high quality alcohol.
- Separate salt from the object by the method of putting the object in a distilled water solution including 0.2% BTA and 0.1% Borax. After that, put the object in a vacuum machine and raise the temperature to 121 ^{0}C within 5 hours.
- After that, clean the object once more, and continue by putting it in acrylic resin (Palaroid-B72).
- After 5 hours, take the object from the acrylic resin (Palaroid-B72) and clean it with acetone.
- Take a photograph of the object.
- Put it into a nylon bag using the PR-System.

3. **Conservation Treatment of Wooden Object**

From 04.12.2006 to 15.12.2006 I attended a training course in the conservation treatment of wooden objects, which was organized by the Gangoji Research Institute of Cultural Properties.

Experts from the institute instructed us directly in the practice of the conservation of waterlogged wooden objects according to Japanese methods. Steps to conserve wooden objects are the following:

- Take a photograph the actual state of the object.
- Measure and draw the objects (describe exactly the actual state of the object), and record the weight of the object.
- Clean the object in water.
- Put the object in a solution including water and PEG (the concentration of PEG should be 20%) at a temperature of 60 ^{0}C. PEG is a type of polymer with the chemical formula HO(CH2CH2O)nH, where “n” signifies the degree of polymerization.
- After putting the object in water, we should continue to put it in the solution with PEG increasing to 40%, 50%..., up to 100%. We should mention that during time in the water we must always check the dimensions, weight, and the changes in the surface of the object. Then we can change the methods to steep them in the water.
- After finish to steep in the PEG, we need to clean the black material from the surface of the object with alcohol at the ratio of 70% alcohol and 30% water.

Study Trip to Museums, Temples and Archaeological Sites

During the training course, the National Research Institute for Cultural Properties, Tokyo and the National Research Institute for Cultural Properties, Nara organized some excursions for us such as to the National Museums in Tokyo and Nara. We also visited the Asuka Fujiwara Imperial Palace Site, Kofuku Temple, and some other places, where they had discovered archeological sites in Nara and in other prefectures. The staff of those institutes enthusiastically introduced us the significance of the places where we visited, as well as how they had been discovered.

My Responsibilities Returning to Vietnam

The training program was very important and relevant to me; it supplied much information related to conservation, and more new techniques for preserving the cultural heritage.

I was able to gain a systematic understanding of the advanced conservation and restoration of cultural properties. I was made aware of the serious impact that air pollution has on our cultural properties. I learned the process of how different elements in the air damage cultural properties made of wood and metal, and realized the importance of measuring the environment. Recently the Hanoi People's Committee has established a management centre for the Thang Long Citadel Site. This center will have as its responsibility the management of conservation and the investigative activities at the Thang Long Citadel Site. The Department of Cultural

Heritage, where I am working, will have the responsibility of instructing the management centre of the Thang Long Citadel Site in the professional skills needed to manage the conservation and investigation of this citadel site. Therefore, after this training course I will impart my knowledge, which I have received from the training course about the conservation treatment of metal and wooden objects, to the management center's staff. I will suggest that the center implement the conservation of the metal and wooden objects which they have discovered at the Thang Long Citadel Site. Firstly we need to conserve metal objects by the method of cleaning carefully the discovered objects and putting them in polyester bags using a PR system and placing them storage, where we should use a temperature and humidity management system. For wooden objects we need to put them in bags of water and place them in storage until our center is able to conserve them by PEG method, or high quality alcohol, etc.

In my working position I will give my best efforts to disseminate the knowledge which I have received from this training course to the staff, who is working in Vietnam museums. It will help them to learn new methods for conserving archeological objects, after archeological discoveries in their provinces.

The Comparison between the Conservation Treatment Metal and Wooden Objects in Japan and the Recently Particular Conditions in Vietnam

According to the knowledge received in this training course, in Japan the conservation of archeological wooden and metal objects has been implemented in accordance with a strict process. The objects are conserved during the excavation period and before send them to storage. They also are protected when displayed and in use.

However, it is quite different in Vietnam. Due to the objective conditions in Vietnam, we only started the first period of implementing practices in the conservation of cultural properties. Scientific research in the conservation of cultural properties is almost zero; equipment and experts in the conservation fields are lacking. In the excavation process, the archeologists have been conducting the excavation only to reveal the exact historical value. The equipment, which is used during the excavation and conservation, is rudimentary. After the excavation, wooden objects are only put in water, and metal objects are only numbered and sent to storage without temperature and humidity control systems.

After the excavation, these objects will be brought to provincial or national museums for collection or display. But the objects are only cleaned by hand, after which they are numbered, photographed (with ordinary cameras), measured and put in the stores of museums.

In Vietnam up to now, there have not been any organizations or departments with extensive experience in the conservation treatment of wooden and metal objects after excavation. Therefore wooden metal have never been treated with PEG, high quality alcohol, drying or cooling methods, and metal objects have never been cleaned by machine, never photographed with X-ray equipment (XRF, XRD). Therefore we cannot evaluate the situation of damages for those metal objects. They have never been treated in acrylic and BTA, never been conserved in PR system before putting them in the stores of the museums.

The museums have not found any methods for restoring objects when displaying and taking them from storage. During display, these objects have never been managed strictly regarding the temperature, humidity, and light source. We do not have any method to avoid bringing metal objects from low temperature to high temperature spaces.

Given the above situation, we can say that the conservation of excavated objects in Vietnam does not meet the necessary requirements for keeping them over the long term.

An Evaluation of the Suitability of this Training Course for Conservation Work in Vietnam as of 19/12/2006

Up to now, in Vietnam we have not had any university or research institute conducting research and training in conservation for staff, and Vietnamese museums have not done any conservation treatment of metal and wooden objects. We need a long period in order to meet the standard existing in Japan now. However, because we have the same kinds of conservation objects as in Japan, with regard to the methods of conservation treatment of metal and wooden objects which I have encountered in the training course, I think that the content of the ACCU training course is suitable for our conservation work in Vietnam. However due to objective reasons, in Vietnam the material facilities and expertise are very lacking. I think that in the near future I can put into practice in some conservation activities for wooden and metal objects, as follows:

The Vietnam Ministry of Culture and Information will request the Department of Culture and Information, which has responsibility for excavations, to prepare all nylon bags and equipments in which we will steep wooden objects during and after the excavation. They need to prepare enough PR system to conserve provisionally of the metal objects before we have the necessary conditions for treating them with PEG, high quality alcohol, and freeze drying etc.

We can disseminate to museum staff (which have responsibility for preserving archeological ancient exhibits) the significance of and the methods for preserving objects by controlling temperature, humidity and light source in storage. We can issue instructions and strict rules for all museums on how to bring metal objects from low temperatures to high temperatures to avoid the condensation of water on the surface of the objects. And we will allow them to display objects when they meet requirements about the control of temperature, humidity and the light source.

Acknowledgements

I feel that the two-month training course at ACCU in Nara, Japan, reached a successful conclusion. I would like to extend my thank to the Asia/Pacific Cultural Centre for UNESCO (ACCU), Nara, Director General of ACCU YAMAMOTO Tadanao. My special thanks go to Mr Toshihiko Morimitsu (Director Program), Mr Atsushi Nagai, Mr Tsutomu Yamashita, Ms Yasuko Otani and ACCU all office staff members, to teachers and instructors of the National Research Institute for Cultural Properties, Tokyo, the National Research Institute for Cultural Properties, Nara and Gangoji Research Institute of Cultural Properties that spent time teaching me. I am also pleased to give thoughtful regards to the Japanese Embassy in Hanoi (Vietnam), the Vietnam Ministry of Culture and Information, the Vietnam Department of Cultural Heritage for nominating me to participate in this beneficial training course.

Final Report

Nguyen Van Anh

The training course on preservation and restoration of cultural heritage was organized by Cultural Heritage Protection Cooperation Office, Asia/pacific Cultural Centre for UNESSCO in Nara, Japan (ACCU), from 6 November to 21 December.

The training was held by Dr Aoki, Dr Inutake of National Research Institute for Cultural Properties, Tokyo; Dr Soichiro Wakiya of Independent Administrative Institution National Research Institute for Cultural Properties, Nara; Dr Naomi Ueda, Dr Inoue Michiko and Mr. Murata Tadashige of Gangoji Institute for Research of Cultural Property. The program has two parts: (1) theory and practice of preservation and conservation technical and (2) field trip.

Ⅰ.The technical content of the training course.

The theory and practice of the training course focused on two important subjects: a general introduction to cultural heritage preservation and conservation science; archaeological artifact preservation and restoration. This report can only serve as a summary of some main topics as well as what I have learnt in this training course.

I.1. Cultural heritage conservation science.

Cultural heritage preservation and conservation have two main objects which are remaining and artifacts. The structural remains include monuments on the ground such as pagodas, temples, etc., and relics under ground that are generally referred to as archaeological site. The artifacts are excavated from archaeological sites and kept in museums.

The effect of the natural environment is an important factor in the destruction of cultural heritage. There are four main factors affecting cultural heritage, involving water, light, air and temperature, acting together and influencing the maintenance of objects.

- Water: The control of water action on sites and artifacts is the most important factor in cultural heritage protection. The water exists in three states: liquid, vapor, and hard (ice). The state of water is influenced by light and temperature, and will evaporate at high temperatures or be frozen at low temperatures. The water could have some dissolved material, especially salt, giving different effect on sites and objects. Evaporation of water makes sites and artifacts dry and change form. Otherwise wet air is a favorable condition for the development of fungus and bacteria working to destroy sites and objects.

- Light: Light includes many various rays, however during conservation of the cultural heritage we have to consider three rays: infrared ray, ultra violet-ray and X-ray. Radiation of these on the surface of sites and artifacts will have bad effects and destroy the cultural heritage. Infra-red rays increase the temperature of the sites and objects making the evaporating process of the water faster. Ultraviolet rays induce chemical reactions, causing the surface color of the artifacts to change quickly. In preservation and conservation in Japan, the light is controlled very strictly. Artifacts shown in museums can not receive radiation of over 80 lux for fine arts and textiles, or 120 lux with earthenware, and the total time radiated is not over 50 thousands/1year

- Temperature: Temperature is affected by light, when the light radiates, infrared rays make the temperature increase. Increasing the temperature drives the evaporating process of water faster; chemical reactions easily occur and influence the growth and development of microorganisms.

- ***Pollution of the air***: Air pollution is one of the important factors demolishing the cultural heritage. It causes acid rain. Archaeological objects and historical monuments may be deteriorated by acid rain. Air pollution leads to increase in the content of sulfur and nitrogen in the air. These combine with water vapor on the surface of objects and create forms of acid. These erode the surface of the object and destroy it step by step.

I.2. Conservation and reconstruction of archaeological objects

Archaeological objects are classified into many categories according to the material and production technique. An artifact is classified as organic or inorganic based on the material. The organic objects include wooden objects, textile, lacquer, etc, and the inorganic objects involve metal objects, earthenware, stone objects, etc. This material classification of objects plays an important role in conservation treatment and artifact reconstruction processes. In accordance with the types of material, various treatment methods are applied. In this training course, I have studied about the conservation technique for waterlogged wood, the conservation treatment of metallic objects and the reconstruction of earthenware.

Understanding the material and production techniques is the first fundamental of preservation and conservation for archaeological objects. Hence before treatment we must answer questions such as: What is it made of? How was the object made? What is the state of the object? The answers help us choose the best method of treatment.

I.2.1. Conservation techniques for waterlogged wood.

In Japan there are many conservation methods for waterlogged wood. In the course work that was held at the Gangoji Institute for Research of Cultural Property, I have learnt about general conservation techniques for waterlogged wood and I have practiced some treatment methods. Waterlogged wooden objects are made of many kinds of wood with different characteristics, so before treatment we have to analyze to know the particularity and structure of the wood. From this basic information we choose the acceptable treatment method. I have experimented with four treatment methods: PEG treatment method, freeze drying treatment method, lactitol conservation method and natural drying method.

I. 2.1.1. PEG treatment method.

PEG is a type of polymer with the chemical formula HO(CH2CH2O)nH, where “n” signifies the degree of polymerization.

At normal temperatures, PEG exists in stable form, but melts at high temperature (55^0C) and dissolves in water. Waterlogged wooden objects are soaked in PEG at various solutions at 50^0C temperature condition. The solution of PEG is increased little by little. In this process the PEG will gradually replace the water in object. At the beginning the solution usually is 10 or 20%. The length of time depends on the scale and characteristics of the object.

After treatment with PEG, objects are cleaned with alcohol and dried. Wooden objects should be kept at low humidity.

I. 2.1.2. Freeze drying method.

Waterlogged wooden objects are soaked in a low solution of PEG. The solution of PEG is increased gradually to 40%. After that, the objects are kept at -45^0C and are frozen by a freezing machine.

I. 2.1.3. Lactitol treatment method.

Lactitol is sugar alcohol composed of galactose and glucose units. Trehalose is also sugar alcohol. Lactitol and trehalose can be mixed at a ratio 9:1. Lactitol treatment method is usually applied when objects which are decayed are soaked in sugar alcohol solution at a 50^0C temperature condition, beginning with a low solution and increasing step by step to 80%. Soaking time depends on the scale and characteristics of the object.

After treatment the objects are cleaned in 60 -70^0C hot water and then made to be dry by dry lactitol in 50^0C temperature condition.

I.2.2. Conservation method for metal objects.

Metal objects are made of many kinds of metal such as copper, bronze, and iron, gold, tin, etc, so before treatment we also must know the material and production technique. This basic information helps us choose an acceptable treatment method. In the training course, I have learnt about an experiment metal treatment method at Independent Administrative Institution National Research Institute for Cultural Properties, Nara. There I have conducted experiments with two major materials, bronze and iron.

I. 2.2.1. Bronze object conservation method

Conservation method for bronze objects involves the following basic steps:

- Observe and record the characteristics, draw and photograph objects before treatment. Investigate and identify corrosion products as harmful or useful.
- X – ray radiography to know structure of object
- Cleaning the surface of object
- Consolidate the object in 3% solution of BTA under a decompressed condition for 5 hours.
- Consolidate the object in acrylic resin (Palaroid B-72) in acetone-toluene mixture under decompressed condition (500hPa) for 5 hours.
- Wash the surface with acetone
- Take pictures after treatment

- Protected with a RP system.

I. 2.2.2. Iron objects conservation method.

With iron objects, conservation and treatment are carried out as follows:

- Observe and record the characteristic, draw and photograph the object before treatment. Investigate and identify corrosion products as harmful or useful.
- X-ray radiography to know structure of object
- Cleaning the surface of object
- Remove the chloride of iron objects with a high-temperature and high-pressure device (object soaked in mix solution 0.2%BTA and 0.1% nastri boras; temperature 121^0C; pressure 1216hPa; time 120min)
- Consolidate the object in 20% solution of NAD under decompressed condition for 5 hours.
- Wash the surface of object with Naphtha and acetone – toluene mixture.
- Take pictures after treatment
- Pack the object with a RP system.

I. 2.3. Reconstruction of earthenware.

At the National Research Institute for Cultural Properties, Tokyo, I also got an overall view of earthenware reconstruction techniques. Previously in Japan, epoxy resin was usually used in the reconstruction of earthenware, but epoxy resin is firmer than earthenware and therefore in recent years acrylic is used more popularly in the reconstruction of earthenware.

II. Field trip

In parallel with the technical content, we also had field trips to Todai-ji, Kofuku-ji, Yakushi-ji, Horyu-ji, Gango-ji temples, the National museum of Nara, the Nara Imperial Palace Site and the Fujiwara Palace site in Nara Prefecture. I have also visited the Edo-Tokyo Museum in Tokyo, Osaka Museum of History and Osaka Castle in Osaka city; Rokuon-ji, Kiyomizudera, Ryoan-ji temples and ancient streets in Kyoto city under the guide of Mr Yamashita Tsutomu, Mr Morimitsu Toshihiko, Mr. Inoue, Akiko Tashiro. These are very famous heritage sites showing successful preservation and conservation in Japan. Through the field trips, I could understand more not only about the culture but also about the technical science achievements of Japan. This was also a practical lesson for learning how to implement preservation and conservation of sites and objects of Vietnam in the future.

III. Conclusion

For me the training course was very successful in terms of both its content and organization.

The content of the training course provided to me the necessary knowledge for preservation and conservation implementation of sites and objects. And it will be very useful for me to carry out in Vietnam. There are many wooden and metal objects that have been found at Thang Long imperial citadel site of Vietnam, but until now they have been not conserved by conservation techniques because there are no experts in conservation in this field in Vietnam. Hence, so these technical solutions will be useful in conserving highly valuable objects at Thang Long imperial citadel in Vietnam.

The training course was held at different places, including the National Research Institute for Cultural Properties, Tokyo; the Independent Administrative Institution National Research Institute for Cultural Properties, Nara and Gangoji Institute for Research of Cultural Property. And all of the teachers are the top experts on preservation and conservation of Japan. Therefore I was very lucky to be able to learn from them and also to experience exchanges about treatment and preservation method for cultural heritage.

After almost two months of study here, I have learned many important lessons. When I go back to my country, I would like to share my new-gained knowledge and skills with my colleagues. And I am really believe that they will be of help to us not only in conserving Thang Long citadel, but also at other site in Vietnam

However the techniques and methods of conservation require the use of advanced machines so it is difficult to apply conservation techniques in Vietnam. So we need more support from the government and other funding sources.

During my study here, I really felt that the organization committee and the teachers are very fervent, openhearted and friendly. I would like to show my deep appreciation for that. And I hope that we will further continue to cooperate with each other to conserve the cultural value of humankind.

Ⅵ Appendix

1. List of Lecturers and Interpreters
2. List of Staff Members, ACCU Nara

1. List of Lecturers and Interpreters

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