

Abstracts

Section 1

Continental connections: bronze and ceramic traditions and their impact on Yayoi
Japan

James Coburn

The Korean Peninsula and Japanese Archipelago have been intimately connected in many ways since the beginning of the people of both regions. However, during the Mumun (Bronze age) period of the Korean Peninsula came the most impactful interactions between the two groups. During this period the Jomon people of Japan and Samhan people of Korea started exchanging more than simple trade good. This is evident in the archaeological materials found in both regions. This paper will look specifically at the exchange of Bronze goods and ceramics coming into the Japanese archipelago. It will detail the significant role that the Mumun pottery and bronze dagger traditions played on the developing Japanese culture. It will also question the idea that the cultural exchange was only one direction as some scholars have suggested. Furthermore, I will look at the idea of Yayoi foundries and their role the development of new bronze traditions that were developed within this period.

The characterization of Korean lacquered artifacts from the late 19th- early 20th period

Herant Khanjian

A collection of richly decorated Korean mother-of-pearl lacquerware, from the late 19th and early 20th century, were investigated as part of collaborative project between conservators from the Asian Art Museum of San Francisco and conservation scientists from the Getty Conservation Institute. The systematic study of Korean inlaid lacquerware collection was initiated to enhance the overall understanding of decorative

Asian objects and elucidate historical use of material and techniques in the Korean peninsula. The secondary focus of the study was to amplify the understanding of artist materials and techniques utilized during the 19th century Joseon period. The close collaboration between conservators and conservation scientists was key to interpreting the objects' manufacture.

Several analytical techniques, including Py-GC/MS, FTIR, SEM-EDX and light microscopy were employed in the study. The comprehensive layer-by-layer analysis of the cross-sections provided critical information that would likely have been missed if only the surfaces had been sampled. Analysis results showed the objects are made using a mixture of traditional lacquerware techniques and materials together with new materials and methods. The objects were found to have only two or three layers above the ground layer, in contrast to observations from previous Asian lacquerware analysis. Catechol-rich Anacard saps were identified in only the red pigmented layer from all four objects while other layers contained shellac and drying oil. Ground layers consisted of clay, quartz, charcoal, animal glue, and drying oil. Shellac was found in the ground layers of at least two objects while the grounds on other objects included crushed bone.

The presence of shellac in the top layers and detection of scant amounts of Anacard lacquer raises some interesting questions about the evolution of Joseon dynasty traditional lacquerware. Various publications discuss the changing of lacquer craft tradition and potential factors that influenced its transformation. It is hoped the study will stimulate discussions about the findings and encourage cultural institutions to share or publish similar layer-by-layer analysis results.

Research progress in dyestuffs and dyeing techniques of ancient East Asian textiles

Jing Han, Xia Wang, Yixuan Zhang

Since ancient times, color, with rich cultural significance, has been an important element in textiles. Dyestuffs and dyeing techniques used in different periods, regions

and ethnic groups varied. This presentation reviews recent studies in ancient East Asian textile dyestuffs and dyeing techniques. Research ideas and methods with typical cases were discussed. Prospects for the research of dyestuffs and dyeing techniques of unearthed textiles were explored.

First, research on the evolution of dyestuffs and dyeing technology over region and time was undertaken by dye identification of unearthed and handed-down textiles, ancient document research, simulation experiments and ethnographic investigation. Second, the identification of dyes on unearthed and handed-down East Asian textiles by micro-invasive and non-invasive methods assisted the sourcing, dating and authenticity study of the textiles, and contributed to the knowledge of the production and trade of the dyestuffs and textiles. The qualitative and even quantitative analysis of dye components further clarified the plant/animal species and source. Third, based on the above scientific and historical analyses, further research on ancient East Asian societies was undertaken, such as the relationship between dyestuffs, dyeing technology, and social production, consumption and trade. In addition, investigations into the aging and conservation of textile dyes provided important support for the research of dyed textiles.

For unearthed East Asian textiles, many of which have faded and discolored, how to accurately identify dyes and restore original colors are big challenges. It is suggested to strengthen on-site and laboratory conservation strategies and methods, improve the understanding of dye aging mechanisms, and promote the methods and protocols of dye and auxiliary identification and color reconstruction. Based on the accurate understanding of unearthed textile dyes and the original colors of the textiles, further archaeological research can be carried out to reconstruct ancient societies.

Analysis of materials and techniques of imperial architectural pasting ornament

Yazhen Huang, Shuxuan Shi, Shuya Wei*

Architectural pasting ornament is a traditional Chinese technology of interior decoration with fine paper or textiles, especially in the Imperial architecture during late Ming and Qing Dynasties. In the Palace Museum, one of the most celebrated imperial palaces in China, the exquisite architectural pasting ornament was found in the ceiling of the second floor of Yanqu Building (37th year of Qianlong, 1772), located on the west side of the third courtyard of Qianlong Garden. A comprehensive and system analysis of representative printed papers was carried out. The structure of the sample and the morphological characteristics of the paper fibers and pigments was analyzed by various imaging techniques, including 3D video Microscope and polarizing microscope. The pigments in the green, white and silver paints were investigated by Micro-Raman, FTIR and SEM-EDS. THM-Py-GC/MS revealed the binding media and assisted in the determination of paper fibers. The results showed that the printed papers were consisted of two pieces of mulberry paper and two pieces of bamboo paper, copper resinate used for the passionflowers and scroll grass, lead white for the "swastika" pattern, muscovite for the ground color. Animal glue was used in the paint, and starch was a binder in papers. Copper resinate, a transparent glazes of green pigment, was probably prepared by basic copper carbonate and rosin and often very difficult to recognize under single technology. The THM-Py-GC/MS providing a better understanding simultaneously of the discrimination of different organic materials, including paper fibers, adhesives and synthetic pigment.

Study on the science and technology of La Jian (powder-wax paper) in the Palace of
Qing dynasty

Yue Ma

Processed paper is a kind of paper made by powder filling, coating, dyeing or calendaring with wax for the purpose of writing and artistic appreciation, in order to broaden the use of paper. In the Ming and Qing dynasties, paper processing technology

reached its peak, especially during the Qianlong period. Various exquisite powder wax paper were used in the court.

Powder-wax Paper belongs to a kind of ancient processed paper, which was wax-coated paper, the paper was coated after the wax surface is smooth, increased water resistance, and played the role of moth prevention. This technology has been used since the Sui and Tang Dynasties, but no physical remains have been found.

Takes the dark pink La Jian (Powder-wax Paper) with gold eight Daoist emblems decoration and Tieluo longevity from the Palace Museum as an example, using three-dimensional video microscope, scanning electron microscope and energy spectrometer, X-ray fluorescence scanner, X-ray diffraction analyzer, and ultra-efficient Liquid chromatography-mass spectrometer analysis of its microscopic morphology, structure, materials and technology, and preventive protection. It shown that the wax paper is double-sided coating, with lead white powder layer, wax layer and gold patterned layer on the surface.

Based on the technological analysis of the dynasty paper, the typical wax paper materials and cultural relics are selected as examples to explain the processing technology, and restore such cultural relics, and design preventive conservation schemes. It provides a scientific basis for the value cognition and protection of the palace wax cultural relics in the Qing Dynasty.

Section 2

Nanmu used in burials: long-distance circulation of wood in early imperial China

Chenghao Li, Shengkuan Cui

The use of wood for coffins and chambers in burials is a unique and longstanding tradition in China during pre-imperial (770-222 BCE) and early imperial (221 BCE-25 CE) China. These wooden architectural structures became the most sophisticated and

consumed lots of wood in the early empire period. The tomb of Empress Dowager Ding, dated to 5 BCE, is the most typical example for the extensive use of wood in burial construction. The tomb, located in nowadays of Shandong province in northern China, is the only empress-level tomb that has been excavated in China. The finds from this tomb include a thousand tons of well processed wooden components, from which nearly a hundred tons were identified as Nanmu (*Phoebe* sp.), a precious tree species transported from south China, by anatomical observation and analysis. Comparing with all available published data on archaeological Nanmu from prehistory to the Western Han dynasty was attempted to understand the extensive burial use and long-distance transport of this material. The research indicates that Nanmu began to circulate during the Western Han dynasty and its consumers included elites and wealthy people. This suggests that the use of Nanmu became a social status symbol in the Western Han period.

The study on the forming process characteristics of painted lacquered coffin unearthed at Jingde Temple site in Nangong, Beijing

Qiu-ju He*, Jian Li, Xue-ge Zhang, Xuan Xu, Hang Zhang

In September 2017, a painted lacquer coffin was unearthed near the site of Jingde Temple in Nangong of Shijingshan, Beijing. According to the epitaph, the owner of the tomb was Zhao Liang, who was an eunuch in the jiajing period of Ming Dynasty. The coffin was painted with 317 figures of monks, priests, officials and jugglers. The images reflected the social life, including clothing patterns, architectural structure, funerary custom, religious belief, ritual and music performance. In this study, instruments such as optical microscopy, X-ray detection, scanning electron microscopy energy spectrum, attenuated total reflection infrared spectroscopy, laser Raman spectroscopy, energy dispersive X-ray fluorescence spectroscopy, X-ray diffraction and pyrolysis gas chromatography-mass spectrometry were used to identify the making materials and techniques. The results showed that the coffin was made of cedar wood, and the coffin planks were spliced by iron nails and linked by dovetails. The lacquer painting process

varied from one part to another, with the main picture consisting of the lacquer base, red lacquer, gold lacquer, and cover lacquer, while the thickness of each layer was 0.012-0.06 mm. In addition to the above paint layers, the corner and base of the lacquered coffin have scraping and laminating. The coffin comprehensively uses the techniques including gold drawing, applying ground lacquer, coating with lacquer and applying lacquer mixed with ash in the traditional Chinese lacquer art recorded in XiuShiLu. The pigments were cinnabar, orpiment, gold powder, and cyanine, etc. The main materials of lacquer layers were tung oil, lacquer, protein, as well as cedar oil and rosin. XRD and phenolphthalein test showed that silicate clay such as brick ash was used for the lacquer ash layer, and blood were not mixed. The results of the study were important for the inheritance of traditional Chinese lacquer art and the restoration of painted lacquer coffins.

Methods for evaluating the preservation state of waterlogged archaeological woods

Siheng Li

With the extensive development of underwater archaeology, a large number of precious cultural relics have been excavated. The waterlogged archaeological woods contain precious historical information and are valuable materials for human exploration of ancient civilization, which need to be paid attention to and special protection. It is of great significance to study wood species and main chemical components of waterlogged archaeological woods by modern science and technology, and to evaluate the preservation state of waterlogged archaeological woods. Our group characterized the waterlogged archaeological woods through microscopic morphology, physical and chemical methods, and obtained the information of wood species, the degradation state of wood cell wall, maximum water content, basic density, inorganic compound composition, residual component content and other parameters, so as to comprehensively evaluate the preservation state of waterlogged archaeological woods. The micromorphological analysis can mainly provide the detailed structure, the

degradation state of wood cell wall, and the related results of wood species and the degradation state of wood cell wall. Physical analysis mainly provides basic parameters such as maximum moisture content, basic density and residual basic density of waterlogged archaeological woods. Chemical analysis mainly assesses the chemical composition of waterlogged archaeological woods, reflects the composition of residual wood cell walls, expresses the content of residual cellulose, lignin, extracts and ash, and provides the mechanism of decay at the molecular level. In addition, during the burial process, the inorganic compounds deposited inside the waterlogged archaeological woods will affect the stability of the wood. Therefore, it is important to identify and analyze the inorganic compounds and their content contained in the waterlogged archaeological woods.

Rapid non-destructive prediction of hardness in waterlogged archaeological wood using NIR spectroscopy

Tiantian Liu, Guanglan Xi, Xiangna Han, Yafang Yin, Liuyang Han*

In this study, near-infrared (NIR) spectroscopy was used to predict the hardness value of waterlogged archaeological wood. Waterlogged wooden cultural relics, which are degraded by prolonged exposure to water, provide valuable insights into human history and culture. Conventional methods for evaluating their mechanical properties have limitations. NIR spectroscopy, a non-destructive and cost-effective technique, was applied to 197 samples from ancient Chinese shipwrecks. A partial least squares (PLS) regression model was developed and optimized using different preprocessing methods and spectral ranges. The best models achieved a correlation coefficient (R_c) of 0.97 and a root mean squared error of correction (RMSEC) of 2.39, indicating high accuracy. The models also exhibited good validation performance, with an R_v of 0.89 and a root mean squared error of cross-validation (RMSECV) of 4.43. The established prediction model showed a correlation coefficient (R_p) of 0.89, with a relative standard deviation for prediction (RSD) of 6.9%. These results demonstrate that NIR spectroscopy enables

rapid and accurate estimation of the hardness of waterlogged archaeological wood, providing valuable data for preservation and consolidation strategies.

Study of the lacquering materials and techniques in Eastern Zhou, Qin and Han dynasties

Yingchun Fu, Shuya Wei

Lacquerwares are the precious cultural relics in Asia, which play important role in the history of China. To study the materials and techniques used for making lacquerwares in different period of times is significant for people to understand the development and inheritance of the techniques. In this study, archaeological lacquerwares including lacquer wine sets, lacquer wooden sword, lacquer umbrella, lacquer screen etc. from Eastern Zhou to Qin and Han Dynasties (770 BC-220 AD) were studied. The techniques of Pyrolysis gas chromatography/ Mass spectrometry (Py-GC/MS) and Fourier Transform infrared spectroscopy (FTIR) were applied for the identification of organic materials used in lacquer objects, while Scanning Electron Microscopy and Energy Dispersive Spectrometry (SEM-EDS), Raman spectroscopy and X-Ray Diffraction (XRD) analysis were conducted for the characterization of inorganic components. Especially Near infrared spectroscopy (NIR) combining with chemometrics, partial least squares (PLS) quantitative models were introduced into the quantitative analysis of oil to lacquer ratio in the ancient lacquer films.

The results show not only urushiol (containing 3-pentadecyl catechol) but also laccol (containing 3-heptadecyl catechol) were detected in different lacquerwares. Oils including perilla seed oil, linseed oil and sesame oil, mastic resin, rosin resin and blood

were found as additives, respectively. Different lacquering techniques such as Youshi (oil mixed with pigment to make pattern on the lacquer layer), the Yuanqi (painting lacquer mixed with ash on the objects) and the Caoqi (painting lacquer or refined lacquer on the objects after Yuanqi) techniques were revealed in different periods. In addition, the use of bone ash in the ground layer and varies ground layer making techniques including ash mixed with lacquer, ash mixed with blood and ash mixed with oil were revealed. The study can definitely enrich people's understanding of lacquering materials and techniques in the past.

Section 3

Investigation on the influence of different cooling atmospheres on the coloration of oil drop glaze crystalline spots in Jian kiln

Caishui Jiang, Jianer Zhou, Yuan Fang, Kun Liu, Qifu Bao, Junming Wu

Oil drop glaze is one of the most representative and valuable colored glazes in the Jian Kiln of the Song Dynasty. The coloration of oil drop crystals exhibits richness and diversity. In this study, we employed experimental archaeology and simulated process experiments to investigate the impact of different cooling atmospheres on the coloration patterns of crystal spots. Utilizing advanced scientific testing methods such as XRD, Raman, and SEM, we examined in depth the intrinsic factors influencing the coloration of oil drop glaze crystals. The results reveal that as the cooling atmosphere transitions from oxidizing to reducing and its concentration increases, the coloration of crystal spots follows a pattern of reddish-brown, silver-white with reddish-brown tints, and finally silver-blue. This transformation is closely associated with the types, sizes, and arrangement of crystal precipitates within the crystal spots. The reddish-brown coloration primarily stems from the chemical coloration of randomly oriented $\varepsilon\text{-Fe}_2\text{O}_3$ crystals at the micrometer scale. The silver-white with reddish-brown tints is generated

through the combined effect of total reflection by ϵ -Fe₂O₃ crystals with specific orientations and their chemical coloration. The silver-blue coloration arises from the interaction between the milky-blue color produced by elongated Fe₃O₄ crystals measuring approximately 50 nm and the reflective silver color.

The glazing technique of Changsha wares

Mingyue Yuan, Baoqiang Kang, Jiayu Hou, Hiram Castillo-Michel, Marine Cotte,
Trinitat Pradell*

The Changsha kiln, a prominent export kiln that thrived during the late Tang dynasty (9th-10th century), holds significance in Chinese ceramics due to its vibrant decoration. This research investigates factors contributing to glaze opacity and red decoration in Changsha ware.

Our findings reveal the glaze has a nanostructure with silica-rich droplets in a calcium-rich matrix resulting from high-temperature liquid-liquid phase separation, contributing to the opacity. The Changsha glaze primarily exhibits an oxidized state (Cu²⁺ and Fe³⁺), Cu²⁺ manifest a broad absorption band at 800 nm, resulting in the green of the glazes, while copper-free opaque glazes exhibit creamy. The droplet's size influences the shade of green, with smaller droplets producing a bluish colour and larger droplets a yellowish-green shade.

The red underglaze decoration showcases green and red areas. The central green area is thinner but has higher copper content (2.5%CuO) compared to the red area at the edges(0.36%CuO). The copper-rich green area is fully oxidized, with copper predominantly as Cu²⁺. In contrast, the copper-poor red area exhibits a more oxidized surface(51%Fe²⁺) with a colourless layer overlaying a reduced red layer(100%Fe²⁺). Copper in the red area primarily exists as Cu⁺, even in the red layer(82%Cu⁺ and 18%CuO), and the red colouration is attributed to CuO. Sulphur was detected(0.1wt% SO₂) in the coloured areas. The lower proportion of Cu/S(2.4) in the red layer favours

the CuO formation, which occurs during the final re-oxidizing. This process involves the conversion of Fe^{2+} to Fe^{3+} and oxidation of copper sulphide, resulting in the release of $\text{SO}_2(\text{g})$, the dissociation of copper into Cu_2O and CuO , and subsequent precipitation of CuO , the dissolution of Cu^+ within the glaze.

In summary, this study provides valuable insights into the nanoscale structure and oxidation states of Changsha ware glazes, shedding light on the mechanisms underlying glaze opacity and red underglaze decoration.

The interaction between Persian Gulf and Indian Peninsular during the later islamic period: compositional evidences for the high-alumina glass bangles discovered from coastal sites of Qatar and U.A.E

Qian Cheng, Thilo Rehren, Rob Cater, Xueyan Zhang, Yi Zhai

Glass and Ceramic were widely distributed along the trading routes between the East and West during the trading and cultural exchange, indicating the interactions from manufacturing to consumption society. Around the geographic region of Persian Gulf, not only large amount of ceramic sherds but also glass ornaments and vessel fragments were excavated simultaneously from coastal town sites. During the Islamic period there was a tradition that women always decorated and identified their own status with ornaments like bangles and beads. The archaeological assemblages of glass bangles from North Qatar and U.A.E seem to prove this kind of tradition. After scientific analysis on glass bangles by LA-ICP-MS and SEM-EDS, several glass bangles were sorted out due to the relatively high compositional level of alumina, which is distinct from major group of plant ash soda-lime silica glass, the most common type during the Islamic period.

The paper focused on the several unique outliers which were classified into two subgroups fluxed with mineral and plant ash, and presenting high alumina characteristics as well. The study discussed the possible provenances of the two sub-

groups and displayed a broad landscape of potential distributions of high-Al glass to China, South Asia, West Asia and even Levant.

New insights on the origin of fired steatite beads in China

Siwen Xu, Feng Deng, Idelisi Abuduresule, Wenying Li, Xingjun Hu, Yimin Yang

Glazed steatite beads are among the earliest vitreous materials. Their appearance and diffusion signal prehistoric important developments of technology exchange and globalization; however, little is known about their early spread in East Asia. In this study, we present the characterization of some glazed/fired steatite beads unearthed from Xiaohe Cemetery (1980-1450 BCE) and Kalaya Cemetery (1900-500 BCE) in northwest China through multi-analysis. In particular, the potential of near-infrared (NIR) spectroscopy for rapid and in situ characterization of fired steatite beads is demonstrated. The remaining glaze is successfully identified by SEM-EDS and optical photothermal infrared (O-PTIR) spectroscopy. The results indicate that these beads are fired and have some links with the Indus Valley, so a potential spread route of artifact and technology from the Indus Valley to northwest China is proposed. Moreover, when fired steatite and faience beads were introduced into central China, they played a significant role in the ritual revolution in the Western Zhou Dynasty (1046-771 BCE).

Archaeological beads from Jiangsu province: chemistry, sources and patterns of trade

Xiaoqi Wang, Hui Shen, Yong Zhang, Yunao He, Hong Wang, Huan Hu

Hundreds of beads were found in the archaeological sites of Jiangsu province. In this research, we carefully sorted out the archaeological beads documented in the archaeological reports, and mainly focused on the study of beads excavated from the representative archaeological sites dated from the 3th to 15th century AD in modern Jiangsu province.

The selected beads were firstly defined on typological observation, then analyzed by using X-ray Fluorescence (XRF), Raman Spectroscopy (RS), Scanning Electronic Microscopy (SEM), Electron Microprobe Analysis (EMPA), as well as Laser Ablation Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS). We found that many of them were in monochrome dark red, translucent blue, opaque yellow and translucent green. Some of them were remarkably tiny. SEM and LA-ICP-MS analysis together with the typological observation indicted the beads were Indo-pacific beads with $\text{Na}_2\text{O}-\text{Al}_2\text{O}_3-\text{CaO}-\text{SiO}_2$ recipe, which were different from Chinese typical glass beads. Interestingly, a few of them were very close in size, color and ingredients to those excavated from archaeological sites in Japan and Korea. Meanwhile, the beads decorated with various patterns were also analyzed. The chemical composition yielded that they were $\text{Na}_2\text{O}-\text{CaO}-\text{SiO}_2$ beads.

As an important archaeological material and cultural symbol, beads mirror the social, economic and religious lives of people who have made and worn them and reflect the technological level of the past. In our opinion, the Indo-pacific beads found in the archaeological sites were possibly originated from South Asia in terms of the glass recipes and bead morphologies, and it might be an important evidence of maritime trade from the 5th to 10th century A.D. In addition, the $\text{Na}_2\text{O}-\text{CaO}-\text{SiO}_2$ beads indicated a possible alternative origin and the delicate decorations also showed the sophisticated manufacturing technique and special ownership.

Secondary production model of glass in the Warring States period: evidence from an eye bead glass with multi-sources from the Qin state

Xingyu Du, Qinggang Geng, Jianfeng Cui

Compared to the specialized production model of ancient Western soda-lime glass, the model of ancient Chinese domestic glass industry lacks analysis and discussion. However, we carried out a comprehensive study with technological methods on a glass eye bead dated back to the Warring States Period in Shaanxi Province, which sheds

some light on how the glass is made in ancient China. The results show that this bead consists of three different types of glass. The Blue part of the eye is soda-lime glass with cobalt and copper. The white part of the eye is also soda-lime glass but with calcium antimonate as the colorant and opacifier. The base part of the bead is mixed alkali glass with a small amount of lead and barium. The analysis results indicate that the glass eye bead was made of a combination of three frits from different origins. It is likely that some of the glass raw materials were the frits from the West, while the lead and barium in the base glass indicates that the bead was produced in China. This suggests a specialized production model for Chinese domestic glass in the Warring States period: the primary manufacture centers producing the frits, some of which are from the West and some are produced in China locally. Finally, the frits were distributed to the secondary manufacturing center for remelting to produce the finished products. This conclusion has important implications for the origin of soda-lime glass excavated in China and the production of lead-barium glass during the Warring States period.

Section 4

Application of traditional Chinese medicines in ancient buildings in the Forbidden
City

Qian Zhou

To effectively protect ancient buildings in the Forbidden City, by means of investigation as well as literature search, application of traditional Chinese medicines in these buildings are studied. During the course of construction or rehabilitation, performances of different types of traditional Chinese medicines are discussed. Results show that the tung oil has moisture-proof function, the alum and lime have adhesion function, the 3 of which are widely applied in works such as rammed earth of foundation, stone, floor tile, roof mortar, color painting, pasting and so on; medicines such as nux vomica, golden cypress, large-leaved gentian, realgar and so on are mixed in paste,

which can kill moth; mixture of medicines such as white wax, herb of grace, black charcoal, rosin and so on can be used as binding material to repair stone components; medicines such as realgar, azurite, mineral green, cinnabar, gamboge, lead powder and so on can be used as pigment, part of which can also kill moth; medicines such as unprocessed rehmannia root, radices saussureae, chebulae fructus, ginseng, tuckahoe and so on are put together in a box for suppressing the evil, which has no utility function, but reflect important cultural value.

Research on the application of infrared thermal wave non-destructive testing
technology in the production process of bronzes

Qiu hao Pu

The detection of the internal structural information of ancient artefacts is the basis of heritage conservation work. The commonly used X-ray imaging technology is high in energy and requires perfect protection conditions, which somewhat limits the scope of application and poses certain safety risks to ancient artefacts. Pulsed infrared thermography is a new Non-destructive imaging technology, which can achieve rapid, non-contact and in-situ detection. In this paper, pulsed infrared thermography is applied to the detection of the internal structure of two Warring States period bronze swords. Intuitively obtained the internal crack shape of the bronze sword body, the length of the clay core inside the hilt, and the different internal structure of the ridge strip material inside the composite sword. It also uses the thermal imaging experimental data and characteristic time for analysis and processing to establish the bilayer structure model of bronze material and clay remains, and the thickness of the hilt material of the bronze sword was obtained. The experimental results show that infrared thermal wave non-destructive testing technology can be applied to the study of internal structure detection of metal artefacts, providing information on the internal defects and structure of metal artefacts, and providing a new detection means for the conservation and restoration of ancient artefacts, which has a broad development prospect.

Characterization of the incense sacrificed to the sarira from Famen Royal Temple
during the ninth century in China

Meng Ren, Xinlai Ren, Xinyi Wang, Yimin Yang

Incense has been linked to ceremonies, religions, medicines, and cosmetics worldwide since antiquity. With the opening up of the Silk Road, incense became one of precious trade products between China and other civilizations. Although many historical literatures record the introduction and use of exotic incense in China, archaeological evidence has been rarely found, and little is known about their composition, origin and function. Famen Royal Temple, renowned for storing the sacred finger bone sarira of Sakyamuni Buddha, was venerated by some emperors during the Tang Dynasty (CE 618-907), and a lot of incense had been sacrificed during the luxurious royal greeting ceremonies for Buddha's sarira according to historic records. In this study, we presented the results of chemical analyses on three types of incense discovered in the underground palace of Famen Temple. Elemi resin and highly scented agarwood were identified in two sarira containers respectively. In particular, elemi was firstly reported in Buddhist activities and in ancient China. The fragrant powder kept in a small silver container was a mixture of agarwood and frankincense, providing the earliest direct evidence of making Hexiang (blending of aromatics) in ancient China, also reflecting the contemporary knowledge of exotic incense. Our findings offer a glimpse into incense offerings in royal rituals associated with sarira worship during the ninth century and reflect the impact of the incense trade along the Silk Road in historical China.

A preliminary scientific analysis of leather and parchment remains in ancient China

Bin Han

Animal resource exploration plays key roles in human societal development. In Chinese archaeological research practice, scientific methods have explored in detail the consumption of animal meat in the human diet that provides rich information in reconstructing past human society. Animal skin/hides are also important animal sources for leather and parchment making, and their scientific analysis can provide valuable insights into past societal technology, culture, and social communication. However, cases of leather and parchment archaeological residue analysis have currently not been systematically incorporated into Chinese archaeological practices. Thus, we surveyed scientific analysis of leather parchment with a focus on cases of local studies in China with analytical methods to trace and characterize the animal sources and the type of tannins. The preliminary results reveal that the characterization of archaeological leather residues can provide additional information for animal and plant resource exploration, and in-depth analysis can outline animal source exploration in different periods of ancient China regarding leather making and usage.

Advances in the study of paintings using imaging and sampling methods

Austin Nevin

Research forms an essential component of the work of conservators and conservation scientists. As part of conservation, analysis aims to document the composition and condition of works of art and to diagnose conservation issues. Conservation is resource intensive, and therefore we need to balance the benefits of adopting low-cost and easily accessible methods for technical imaging, with the use of in situ analysis and invasive sampling. Access to increasingly sophisticated portable and laboratory instrumentation based on the use of photonics for imaging and mapping means that today we have more access to more data to inform conservation decisions, and an increasingly nuanced understanding of the complexity of paintings and their stratigraphy on the microscale. This talk will highlight recent advances in method

development for the analysis of easel paintings and wall paintings carried out at the department of Conservation at The Courtauld. Case studies involving the application of technical imaging, fluorescence lifetime imaging, laboratory and insitu methods will highlight how analysis can inform our understanding of chemical and physical changes, and ultimately influence conservation decisions. Examples will range from the analysis and treatment of wall paintings in Rajasthan, to the study of 20th C. paintings on canvas. Practical aspects of conservation that rely on the development of new methods for stabilising and cleaning wall paintings, the assessment of risk, and the impact of treatment will be presented.

Keynote 1

Development and application of silk micro trace detection technology based on immunology method

Yang Zhou

Silk is a kind of protein material that is very susceptible to aging and degradation due to environmental influences. According to the unearthed state of silk relics, they can be divided into physical silk fabric, carbonized silk fabric, mineralized silk fabric and soil samples. Carbonized silk fabric, mineralized silk fabric and soil samples are difficult to identify by conventional methods. In view of this, China National Silk Museum has carried out joint research with Zhejiang University, Zhejiang University of Science and Technology and other universities, and proposed to use immunological methods to analyze and detect ancient silk fabrics.

The immunological technique combines the sensitivity of enzymatic chemical reactions and the specificity of antigen-antibody reactions, which makes it a sensitive and specific detection method. Silk fabric has properties of protein. Taking silk fibroin in silk fiber as the research object, hydrolysate and characteristic amino acid sequence of silk fibroin were used as the molecular markers of silk protein. Polyclonal antibodies

and monoclonal antibodies to silk protein were prepared by animal immunization to achieve the specific recognition of ancient silk fabrics. These antibodies can be directly used for the identification of silk species, and the detection limit can be up to nanogram level.

Based on the preparation of silk specific antibody, the detection techniques of silk micro traces were developed, such as enzyme-linked immunoassay (ELISA), immunofluorescence assay (IFM) and electrochemical immunosensor. it provides a series of sensitive, specific and quick identification methods for the residues of silk. By using the above methods, the problem of identification of silk relics unearthed from more than 20 important sites at home and abroad has been solved systematically, and added a number of important archaeological evidence for the origin of silk and the spread of textile culture along the Silk Road.

Section 5

Evaluating the thermal shock resistance of ancient ceramics

Matthew L. Chastain

Thermal shock resistance refers to a materials ability to survive the internal mechanical forces generated by rapid temperature change. Researchers have long suspected that thermal shock resistance was a significant consideration influencing the technical choices made by ceramic producers in many ancient societies. This present study investigates the thermal shock resistance of ceramic bronze-casting molds from Zhou-period China. These casting molds must have been made from specialized, high-performance materials in order to withstand the extreme temperatures and stresses of the casting process. A novel methodology was developed for assessing thermal shock

performance, as no existing methods used in archaeological science are appropriate for studying these ancient refractory ceramics. This methodology involves measuring several basic materials properties and subsequently using these data to compute the values of thermal shock resistance parameters, which can be used to predict performance differences between material types. A range of replica specimens was tested in order to understand how producers' choices during the mold-making process would have improved or worsened the thermal shock resistance of their ceramic bronze-casting molds. Results are compared among three Western Zhou bronze foundry sites in the Zhouyuan area, Shaanxi province. It is found that producers at these sites employed two distinct but effective strategies for increasing the thermal shock resistance of casting molds: producers at the Zhougongmiao site carefully controlled molds firing temperature, whereas producers at Kongtougou and Lijia carefully controlled molds paste composition.

An experimental study of silt raw materials: replicating the late Shang dynasty bronze vessel casting moulds

Weiyin(Elaine) Cheng

Bronze vessel casting of the Late Shang dynasty has been an interest in archaeometry research due to their use of silt rich materials not found in other artifacts of that time. Exactly how the ancient artisans produced the bronze vessel casting moulds remain unclear. Although archaeometry can determine the likely steps involved in producing the moulds, the data collected is only the start to comprehending the overall production of these casting moulds. This research uses experimental archaeology to replicate the data found through petrographic and SEM analysis of the two Late Shang dynasty mould types housed at the Royal Ontario Museum (ROM). Replicating the archaeometric data with experimental archaeology can further our comprehension of the steps involved in producing the casting moulds and better connect

the data to the artisans' movements and procedures. At the same time, determine if the analysis results support the mould sets' physical production.

Bronze production during the Eastern Zhou dynasty: analysis of slags from the
Xincun and Baidian foundry sites in Central China

Cong Wang, Zhenlong Gao, Quanyu Wang*

Studies on metallurgical remains of the Eastern Zhou period in Central China have been scarce due to limited materials. The Xincun and Baidian are two of the important foundry sites of the Eastern Zhou period, with the main remains of the Wei and Jin states, respectively. This paper aims at reconstructing the technological landscape of bronze production processes at both sites and exploring the differences and/or similarities between the bronze processing activities at the two sites in different historical contexts.

Elemental and microstructural examinations demonstrated that some of the slags from both sites may represent a co-smelting process, in which tin ore was probably added to molten copper to produce bronze. Additionally, remelting of waste bronze for alloying was also applied at the Baidian foundry site. The higher smelting temperature and more stable reduction atmosphere at the Baidian foundry site may indicate more advanced metallurgical technology in the Jin state than in the Wei state. Lead isotope analysis showed similar data between these two sites, which points the lead source likely to the western Henan region.

These findings provide valuable insights into technology and resources in different foundry sites during the Eastern Zhou period, and have important implications for future research in this field.

Petrographic analysis of the casting cores unearthed from the Sanxingdui site

Xiaotian Zeng, Huiru Lian, Kunlong Chen

In 1986, archaeologists found two pits in Sanxingdui site. Numerous Shang-dynasty bronzes have been excavated in these two pits with a huge quantity and a rich range of forms and decorations. The scholars in a wide range of disciplines are interested in the preservation and the scientific research to create the bronze objects unearthed from the two pits of the Sanxingdui site. Although researchers have carried out a number of studies on this topic, the casting sites of the different types of the Sanxingdui bronzes remain unclear. This research for the first time use petrographic analyses to conduct the material characterization of casting cores from this site. All of the samples are from the bronzes unearthed from the two pits of the Sanxingdui site. The petrographic analyses show that the casting cores can be divided into two groups on the basis of varied mineralogical, corresponding to vessels and non-vessels bronzes. And the river sand was found as the main raw material for the casting cores manufacturing. The two groups differ in mineral composition, sorting, roundness and the content of clay. Several biotite, muscovite and amorphous calcium carbonate could be found in the casting cores of the non-vessel group. And casting cores of the vessel group had higher content of the clay. By comparison with geological samples from the Sanxingdui site, the casting cores of the non-vessel group were not consistent with the local soil and sand geological characteristics but had the same mineral composition. And the casting cores of the vessel group were largely different from the local soil. It can be further speculated that the Sanxingdui bronzes would have several casting sites and most of the vessels were first casted outside of the Sanxingdui site.

A preliminary study on the bronze-imitating miniature clay wares during Spring and Autumn period unearthed from Xinzheng, Henan

Ji Zhang, Wenquan Fan, Longjun Li

Xinzheng has buried miniature bronze-imitating clay ritual vessels in tombs since the early Spring and Autumn Period, and such wares became popular in the late Spring

and Autumn Period. The height of this kind of artifact is usually less than 5 cm, which is a miniature and hint of similar bronze ritual vessels. Some of them have relatively delicate imitation details, while most of them are simple in appearance. Through microscopic observation and compositional analysis, it is shown that the material of this kind of wares is not mud or pottery, but similar to that of clay molds made by silt and fine sand. The bronze melt adhering on the surface during the casting process were preserved on some miniature wares, indicating that the material of such vessels may be clay cores taken out after casting bronzes. These wares were buried in the tombs around the city of state Zheng, and they may be used to express specific funeral meanings, which will help to deepen the understanding of the waste materials of the bronze casting industry in the Central Plains, and also help to expand the concept of bronze ware.

Section 6

The forming of Qin Empire: a case study of poleaxes and mous unearthed in Chengdu
City, Southwest China

Wugan Luo

The successful administration of Qin State in the Shu region during the Warring States Period laid a solid foundation for the establishment of the Qin Empire. However, there has been limited research that examines the Qin and Shu regions from the perspective of copper metallurgy in archaeology. This study employs typology, X-ray imaging, alloy composition, metallographic microstructure, trace elements, and lead isotopes analysis methods to analyze two types of bronze artifacts, namely, bronze mous and bronze poleaxes, before and after the integration of the Qin and Shu regions. The study aims to discuss the management and transformation patterns of bronze craftsmanship in the Shu region under Qin's rule.

A provenance study of Bronze Age metal objects from the Ili Region, Xinjiang, China

Jun Gao

Among scholars, the discussion on the provenance of early bronze artefacts in the Ili area has produced two opposite opinions: indigenous and imported. This paper compiles lead isotope data on nearly a thousand metal artefacts and copper deposits in Ili and surrounding areas, and discusses the provenance of metal artefacts found in Ili. Studies have shown that the Afanasievo culture in Ili may have exploited local ores for metallurgical production since the beginning of the Bronze Age. The local metallurgical industry continued to flourish and had a strong influence on the surrounding areas. In the first millennium BC, along the Tianshan Mountains from the Ili area to the east, there may have been a general shortage of tin supplies, which led to a decrease in the tin content of Iron Age bronzes and the widespread use of copper artefacts. This study contributes to a deeper understanding of the historical mosaic of early metallurgy in the Ili area. In addition, it provides a new perspective for analyzing the motivations of early migration and nomadic development.

Resolving the complex mixing history of ancient Chinese bronzes by Manifold Learning and a Bayesian Mixing Model

Zhenfei Sun, Siran Liu, Ji Zhang, Kunlong Chen, Brett Kaufman

Provenance of metals is a major theme in Bronze Age archaeology since it can help to reveal complex cultural and economic entanglements in ancient times. However, where complex societies with diversified trading relationships are concerned, identifying metal provenance has often proved to be challenging due to the frequent mixing of metals from different sources in antiquity. This research addresses this question by developing an innovative method for interpreting lead isotope data of bronze artefacts. Manifold learning and a Bayesian mixing model are combined to reconstruct quantitatively the contribution of metal sources to ancient bronzes. The methodology is employed to resolve the complex metal circulation system in the Zhou period (11th-3rd century BC) of China, and reveals a significant diachronic change of metal resources from North, Central, and South China. The North China metal sources

were mainly employed in the Early Western Zhou period (1046-950 BC). In the following ages, the Yangtze River Valley and Qinling Mountains became the major metal sources for Zhou people. The Middle Spring and Autumn period (660 BC-560 BC) witnessed a major shift of dependence between these two sources, demonstrating a fundamental transformation in the metal circulation system. The South China metal sources were exploited throughout the entire Zhou period and probably associated with polymetallic deposits in the Nanling area. This research reveals the long-term patterns of metal exploration and mixing in the Zhou period of China, and also demonstrates the great potential this new methodology promises in addressing the complex metal mixing history in other cultural contexts.

Politics and society of the late period of Rui State: technological perspective of the
bronze artefacts unearthed from the Liujiawa Site

Yijie Hu, Zhanwei Sun, Jianrong Chong, Ji Zhang, Lei Jiang, Jianli Chen

The bronze artefacts unearthed from the Liujiawa Site, the capital city of the late period of Rui State, were analyzed in order to reveal the technology of the metal artefacts in the eastern part of Guanzhong Plain in the early and mid Spring and Autumn Period and explore the political system and societal structure of the Rui State. The results show that the tin content of the bronze vessels from the medium-grade tombs is significantly lower than that of the high-grade tombs. The tin contents of bronze weapons and chariot and horse fittings are mostly concentrated in the appropriate range due to the mechanical requirements. The lead isotope ratios of most of the bronzes from Liujiawa Site are consistent with the data of the bronzes in the early Spring and Autumn Period, while the ratio of some bronzes unearthed from the later period tombs, is close to the ratio of the bronzes in the mid Spring and Autumn Period, which provides a time point for the change of lead materials in Guanzhong area in the early and mid Spring and Autumn Period. Some bronze cauldrons with Northern cultural factors were excavated from Liujiawa Site while the lead isotope ratios are similar to the bronzes

with traditional Central Plain style. According to the results, we infer that tin resources in the early Spring and Autumn period may depend on long-distance transportation, and the location of Rui State was remote from tin resources, so there were obvious class divisions reflected from resource distribution.

Lead isotopic analysis of Han bronzes from the Chenzhou area: a new perspective on ore source supply during the Western Han period

Wengcheong Lam, Wenli Zhou, Shengqiang Luo, Ji Zhang, Linheng Mo

Previous lead isotopic studies have documented significant shifts in the ore sources used for Western Han bronzes, coinciding with the unification of the Han state and the expansion of the imperial network. While the literature has predominantly emphasized the prevalence of Eastern Qinling region's ore sources during this period, the significance of ore sources from the broader southern frontiers, particularly the southern Hunan-Nanling mountain ranges, has been largely neglected. Considering the substantial role these regions played as suppliers of raw materials during the Eastern Zhou period, investigating whether local sources continued to be utilized during the Western Han period is essential for a comprehensive understanding of the Han empire's ore supply transformation. This study presents the results of lead isotopic analysis conducted on Han period artifacts from the Chenzhou region in southern Hunan, unveiling intriguing findings. While some imported bronzes, including coins and mirrors, originated from non-local ore sources, the majority of vessels discovered in the Chenzhou region were made using ores from the southern Hunan-Nanling mountain ranges. This new dataset sheds light on the sustained utilization of ore sources from the southern frontiers during the Han period, offering valuable insights into the diverse transformations within the bronze industry during the consolidation of the Han state.

Section 7

Lines of typological evolution of bronze vessels from the sacrificial pits of
Sanxingdui

Andrey V. Varenov

Lines of the possible typological evolution of bronze vessels from sacrificial pits of Sanxingdui are outlined and reconstructions of ways of their everyday use are given. There are five bronze vessels of four different categories in the first sacrificial pit (JK1): two zun, one bu (pou), one pan plate and one gai lid. In the second sacrificial pit (JK2), at least 12 bronze vessels of only two (or three) categories (excluding gai lids) were met: 8 zun vessels, 4 lei vessels and, perhaps, a hu vessel. Because categories are scarce in Sanxingdui collection of bronze vessels and zun vases are the most numerous among them, the author proposes to divide zun vases from Sanxingdui into two variants: A and B. Zun of A variant has the plain upper part of the base with rectangular holes in it. Zun of B variant has the upper part of the base with two or three lines in relief and cross-shaped holes in it. Differences between zun of A and B variants have no technological or semantic meaning and represent two variants of tradition of casting of those bronze vessels. The development of two variants of zun bronze vessels in Sanxingdui came in parallel and followed the same lines of the typological evolution. Two variants of bronze vessels of the same category at the initial stages of functioning of sacrificial pits presume the existence of two traditions borrowed from the Central Plain and represented by two craftsmen who stood at the cradle of Sanxingdui bronze casting for a number of years. Bronze vessels in Sanxingdui were used in combination with bronze masks of C type from the sacrificial pit JK2 and bronze heads of A type from the sacrificial pit JK1 as parts of huge anthropomorphic sculptures with wooden core.

The development of copper smelting technology in the Mid-Shang dynasty: evidence from Tongling site in northern Jiangxi province, China, ca. 1400BC to ca. 1300 BC

Guisen Zou, Yanxiang Li, Siran Liu

The development and utilization of metal resources in the Yangtze River Basin laid an important material foundation for the rise of early Chinese civilization, and at the same time led to the southward expansion of the Central Plains civilization, which accelerated the rise and development of civilization in the southern region through collision and fusion. The key geographical location of northern Jiangxi and its rich copper and tin resources make it play an important role in this process. The Tongling Site in Ruichang, Jiangxi is currently the only Mid-Shang Dynasty site that integrates mining and smelting found in the middle reaches of the Yangtze River. The Tongling site provides important materials for the study of metallurgical archaeology in the Shang Dynasty in China. This study will carry out scientific analysis and research on the smelting relics unearthed at the Tongling site, establish a metallurgical operation chain at the site, and discuss development of copper smelting technology in Mid-Shang Dynasty from Jinzhong to the middle and lower Yangtze River region.

Identifying recipes of Ming and Qing cupels from Dali, Yunnan

Ao Sun, Huimin Wu, Tian Liu, Yuchen Wang, Siran Liu

Cupellation is the most important silver extraction technology in ancient China. At least since the Han Dynasty, China has adopted cupellation in silver extraction. The by-product litharge is the most significant physical evidence that can be available to identify raw materials and recipes of the archaeological cupels which were used in the cupellation to extract silver in ancient times. However, there were little archaeological remains from this process that had ever been identified and investigated in China. Here, we present a new find from the site of Beiyachang and Baixiangchang in Dali Yunnan. Six litharge and cupel fragments were identified and generally dated to the Ming and Qing Dynasties. Chemical and microscopic analysis show that cupels were made primarily of a mixture of bone ash (~25-45wt%) and plant ash (~55-75wt%). In ancient documents, plant ash, rather than bone ash, is a common raw material of cupels in China. Scientific

analysis of the Dali litharge provides the first evidence of the use of bone ash and plant ash mixture for manufacturing cupels during the Ming and Qing Dynasties in China.

Shang and beyond: preliminary exploration on the evolution and circulation pattern of the highly radiogenic lead resources in the Shang Dynasty

Renjie Ma, Jianfeng Cui

The source of metal resources in the China Bronze Age has always been one of the most striking issues in archaeology, among which the disputes over HRL in Shang Dynasty, are the most intense. Recently, based on the consensus of "single geological source" and "polymetallic deposit" of HRL resources in Shang Dynasty, some prospective researches show that the HRL resources are not static, and the internal evolution is basically synchronous among regions, which promotes the observation of cultural interaction from the perspective of metal resources. This report introduces the general understanding of the evolution of HRL resources among the Central Plains and its surrounding areas in the second half of the second millennium BC, and divides HRL resources into two groups. Group A is represented by Erligang bronzes unearthed in Zhengzhou and Panlongcheng, and Group B mainly includes bronzes from Huanbei. The slopes of $^{207}\text{Pb}/^{204}\text{Pb}$ versus $^{206}\text{Pb}/^{204}\text{Pb}$ plot are 0.141 and 0.168, respectively. Anyang, the Loess Plateau, Hanzhong and Sanxingdui all have these two groups of data. The phenomenon that the utilization and replacement of HRL resources in the core, periphery and periphery areas of Shang culture are basically in sync implies that this special resource has a single source. The simple center-edge model can't explain the complex interaction between Shang and surrounding bronze civilizations. There seems to be no model that is only influenced by the core area of Shang. Especially during the late Shang dynasty, some semi-edge or marginal areas rose to become new regional centers, and the previous cooperation pattern with Shang culture as a single center was broken and reorganized. The above-mentioned preliminary analysis reveals the regional characteristics behind the consistency of "Erligang style" in the early Shang Dynasty,

as well as the internal relations behind the differentiation of "regional style" in the late Shang Dynasty.

A study on "Tiger and Man" *You* vessels——with a discussion on the relevance of animal shaped bronzes from Yangtze River Valley to the gong vessel

Xiyang Duan

Two "Tiger and Man" you vessels (虎人卣), separately conserved in the Sumitomo collection and Musée Cernuschi, are both said to be unearthed from Changsha, Hunan, China. They are the prominent representatives of Shang bronze art, well-known for the shape of a tiger devouring/holding a man (虎食/抱人). This is a multi-perspective study on "Tiger and Man" you vessels, including an in-depth investigation on their craftsmanship that combined with CT scan results, as well as a comprehensive examination on their form, decoration, and motif. Through analysis on stylistic features, artistic expression, and technical characteristics, it is affirmed that these two vessels were a pair which exhibits a strong southern bronze style of the Shang time. They were made by the same or the same group of artisans, simultaneously casted in a bronze workshop situated in the Yangtze River Valley sometime around yet earlier than Yinxu. The image of "tiger and man" is a peculiar motif that was especially favored along the Yangtze River during the Shang time while up to now the "Tiger and Man" you vessels are the only three-dimensional representations of it. From this pair of you vessels, this study extends its concern to the communication between Yangtze River Valley and Anyang during Shang time and how it was demonstrated on the bronzes. In particular, it concentrates on the relevance of animal shaped bronzes vessels to the gong vessel (觥). On top of reviewing a related precedent study, this essay presents a brief discussion on the emergence of the gong vessel and its early development in Anyang.

Examining the casting techniques of large *Ding* tripods: insights into bronze production during the Middle to Late Shang period

Qingzhu Wang

Bronze ding vessels were considered highly significant ritual utensils during the Bronze Age in China. Large ding vessels, characterized by their exceptional size (height >40cm), emerged during the Upper Erligang period (1550-1400 BC) and gained popularity in the Middle to Late Shang period. This study examines 24 large ding vessels from the Middle period and identifies three variations in the casting methods employed for the tripod supports. These variations suggest a multi-linear evolution of the casting techniques used for large ding vessels. The modifications in the casting methods likely aimed to address casting flaws specifically found in the legs of these vessels.

Section 8

Scientific analysis on the gilded silver crown excavated from Tomb NO.1 in Wulanquangou, Qinghai

Hongyan Xiao, Tao Tong, Jianfeng Cui

The gilded silver crown excavated from the tomb NO.1 in Wulanquangou reveals a mixture of local tradition, Central Plains culture, the Northern grassland culture and Central Asia culture. A series of scientific analysis on the gilded silver crown and the attached jewelries (include pearls, turquoise, garnet and glass) identify a prosperous trade network between Qinghai and Central, west and South Asia, where specialty luxury items were circulating and converged in Qinghai via Silk Roads of the Northern Tibetan Plateau and Maritime Silk Road.

The exchange of the iron process in Western Han Empire: a case study of the
Xingfucheng cemetery, Guyuan, Ningxia, Northwest China

Jin Zhu, Quansheng Huang, Guisen Zou, Cunshi Zhu, Jialong Guo

Located in Guyuan City in the southern part of Ningxia Hui Autonomous Region, the Han Tombs of Xingfucheng (XFC) is a Western Han period cemetery site with higher grade and a larger number of iron tools excavated in Ningxia, providing new information for further research on the manufacturing technology of iron objects and trade and other related situations in the early Western Han period in the northwest frontier region. Scientific and technical means such as energy dispersive X-ray fluorescence spectrometer, scanning electron microscope energy dispersive spectrometer and metallographic microscope were used in this study, the metallographic structure, inclusions composition and morphology of some iron artifacts unearthed from XFC site were observed. This is the first archaeometallurgical study of iron and steel metallurgy in the Han dynasty carried out in Ningxia. The study shows that there are two technological systems of iron and steel smelting-cast iron and bloomery iron-making, quenching, carburizing and other processes were used in weapons production, among which Chaogang product is the first discovered in Ningxia. The iron and steel metallurgy technology reflected in XFC serves as an important representative of the integration of China and Western Asia. Under the tradition of bloomery smelting technology, Ningxia has carried out frequent iron exchange and transportation with the Central Plains region to expand its armed forces and arrange frontier defense, which is conducive to in-depth exploration of the development of iron and steel industry in the Han Dynasty as well as cross-cultural exchange of ancient technology.

Silver hairpin production system in the Late Ming Sichuan

Tian Liu, Siran Liu, Zhiyan Liu

The Jiang Kou Battlefield Site of the Late Ming Dynasty in Pengshan, Sichuan province revealed the largest assemblage of Ming period silver artefacts. They were collected by Zhang Xianzhong, the rebellion general of the Late Ming and Early Qing period, from Sichuan and adjacent provinces. Thus, this assemblage provides important materials for studying the production system of silver hairpins in the late Ming Dynasty. Through comparative study, the Jiangkou hairpins can be divided into three groups corresponding with three different types of production workshops. The first one is argued to be made in independent workshops mainly serving normal people. Metallographic analysis shows they were made with varied forming technologies, including various forging, folding and welding methods. None of them shows as-cast structure indicating there was no standard mould for this type. They were mostly forged by individual works from raw silver ingots. The origin of their raw materials are complex suggest by highly varied trace elements and isotopic compositions. The other two types have much more standardized forming techniques and are associated with large commercial workshops and attached official workshop. Their raw materials had been repeatedly refined. The commercial workshops commonly used forging technology to make their hairpins and the trace element patterns of the hairpins are also relatively consistent. The silver hairpins of attached specialists were all made by casting, suggesting they had a highly standardized system and can copy the same hairpins in fairly large numbers. Their products were mostly found in tombs of emperor and royal families. This research revealed a stratified silver production system in the Late Ming period and demonstrated the strength of material characterization in revealing manufacturing organization models.

EDXRF analysis of silver punch-marked coins from early historic site Tekthta,

Paschim Raghunathpur, Naogaon, Bangladesh

Sabikun Naher, Bulbul Ahmed

The present research delves into the field of archaeometallurgy, explicitly focusing on the analysis of selective silver punch-marked coins discovered at the newly unearthed early historic site of Tekttha in Paschim Raghunathpur, Naogaon, Bangladesh. Tekttha, located within the village of Paschim Raghunathpur in the Porsha upazila of Naogaon District, has yielded a remarkable assemblage of artifacts, including a significant number of ancient coins comprising both silver punch-marked coins and copper cast coins. These coins were found through the surface collection, while the entire site is currently experiencing extensive deterioration due to unauthorized mining activities and the looting of antiquities. The analysis of the coins in this study employs a combination of visual observation, photographic documentation, and scientific techniques. Parameters such as weight, size, and dimensions are meticulously recorded to create a comprehensive record. To facilitate a deeper investigation, the coins have undergone elemental analyses by energy-dispersive X-ray fluorescence (EDXRF). The analyzed coins represent various shapes and sizes, including round, square, rectangular, hexagonal, pentagonal, and irregular shapes. The weight of these coins varies from 2.33 to 3.41 gms. The dimensions of these coins vary from 12.81x10.19x3.11 mm to 20.89x17.78x2.07 mm. Most of the coins are extremely fine, and all coins contain several symbols on the obverse and reverse as well. However, energy dispersive X-ray fluorescence (EDXRF) analysis confirmed that analyzed punch-marked coins from Tekttha are all made of silver (Ag), as silver was found to be a major element in these coins. The concentration (in mass%) of silver (Ag) in the analyzed coins varied from 75% to 99%. Copper (Cu) was also present as a minor element in all samples. The analysis also reveals the presence of iron (Fe), manganese (Mn), vanadium (V), cobalt (Co), nickel (Ni), rubidium (Rb), zinc (Zn), and selenium (Se), with varying concentrations in the studied samples.

Copper technologies and overseas contacts in Taiwan during the Metal Age

Mélissa Cadet, Kuan-Wen Wang, Kwang-tzuu Chen, Cheng-hwa Tsang, Yi-chang Liu,

Chenyi Chu, Kuo-Fang Huang, Yoshiyuki Lizuka

The geographical location of Taiwan has played a significant role in processes of cultural interaction and migrations between the Mainland and the islands around the South China Sea. Copper/bronze metallurgy, for example most probably dispersed via these contacts/exchanges with the mainland, but we still have limited knowledge of how, when and why this occurred. Despite the developments of metallurgical research in the Mainland, the islands have remained understudied. Current evidence seems to suggest that Taiwan did not produce copper locally during the Metal Age, rather raw materials were imported. However, the presence of molds on Taiwanese Metal Age sites indicate that secondary production activities were undertaken on the island, giving rise to a local copper-based craft exhibiting varying typologies which some are still present among aboriginal communities.

In order to bring new data to the questions of transmission and development of copper metallurgy in Taiwan, copper-based artefacts from Shisanhang and Blihun Hanben, two major Metal Age sites are being studied. To date, 58 objects have been sampled and are currently analyzed using an archaeometric laboratory approach (Optical Microscopy, SEM-EDS and on going lead isotopes). In the case of Shisanhang, the results show that some objects, notably vessels, may have been acquired through overseas exchanges. On the other hand, certain types of objects, such as dagger handles with human faces, could have been produced locally in Taiwan as one-offs. Through the copper-based material, Shisanhang and Blihun Hanben seems to reveal different context may be linked to an access to various type of exchange networks.

Keynote 2

A partial prehistory of the Southwest Silk Road: archaeometallurgical networks along
the Sub-Himalayan corridor

Oliver Pryce

Historical phenomena often have prehistoric precedents; with this paper we investigate the potential for archaeometallurgical analyses and networked data processing to elucidate the progenitors of the Southwest Silk Road in Mainland Southeast Asia and southern China. We present original microstructural, elemental and lead isotope data for 40 archaeological copper-base metal samples, mostly from the UNESCO-listed site of Halin, and lead isotope data for 24 geological copper-mineral samples, also from Myanmar. We combined these data with existing datasets (N = 98 total) and compared them to the 1000+ sample late prehistoric archaeometallurgical database available from Cambodia, Laos, Thailand, Vietnam and Yunnan. Lead isotope data, contextualized for alloy, find location and date, were interpreted manually for intra-site, inter-site and inter-regional consistency, which hint at significant multi-scalar connectivity from the late second millennium BC. To test this interpretation statistically, the archaeological lead isotope data were then processed using regionally adapted production-derived consistency parameters. Complex networks analysis using the Leiden community detection algorithm established groups of artefacts sharing lead isotopic consistency. Introducing the geographic component allowed for the identification of communities of sites with consistent assemblages. The four major communities were consistent with the manually interpreted exchange networks and suggest southern sections of the Southwest Silk Road were active in the late second millennium BC.

Section 9

Cinnabar use in the Late Shang Society

Kuang Yu Chen, Jhih-Huei Liu, Yuling He, Weiying Ke, Ming-chorng Hwang

A century of continuous archaeological work at Anyang, the last capital of Shang dynasty (ca. 1600-1050 BCE), has yielded inscriptions and artifacts that authenticated the Shang history and enriched our understanding of their material culture and technical

achievement. We have recently applied micro-Raman spectral analysis and X-ray fluorescence (XRF) to examine the nature of red coloration in soil samples collected from the tomb M103 at Wangyukou village, Anyang in 2009. The tomb owner was a diviner during the reign of King Wu Ding (1255-1195 BCE) as evidenced from the inscription on a small bronze seal and a small jade knife, which was used by Shang diviners to carve inscriptions on plastrons and bones.

The finding of cinnabar in M103 allows us to propose that the so-called zhu layer (i.e. red layer) that appeared in many other Shang tombs could be due to cinnabar. We have therefore surveyed the archaeological literature for excavation reports where the tomb zhu layer, with area and depth given, was described. Using these data we have made a preliminary estimate of the amount of mortuary use of cinnabar at Yinxu during the late Shang time. We propose that just based on the need of funerary purpose, the scale of cinnabar production would be on par with other major industries, such as bones, jades, and bronzes.

Evolving stone drilling technologies in the Japanese Archipelago

Lauren Glover

Stone bead manufacture has thrived in Japan since the Jomon Period. With the change to metal drills in the Yayoi Period (400 BCE-250 CE), different regions in Japan developed their own distinctive chaîne opératoire for shaping and drilling stone beads. This paper looks at stone drilling through scanning electron microscope (SEM) analysis of silicone impressions of the inside of stone beads across several different regions in Japan from the Yayoi through the Kofun/Asuka periods (400-700 CE). The SEM analysis can reveal both details of manufacturing as well as use wear over time. K-Means Cluster Analysis was used to determine and verify groupings of beads according to workshop tradition. SEM analysis revealed that Kofun period beads manufactured in Japan were overwhelmingly drilled with solid metal drills using some type of abrasive, though cylindrical metal drills do appear to have been used sporadically. Often the bead

interiors were too worn by use wear to identify the type of abrasive, or in the case of the softer steatite beads, any details of drilling. Nonetheless, it is possible to identify multiple workshop and regional traditions, as well as changes over time until stone bead manufacture fell out of fashion at the end of the Asuka period. Manufacturing traditions also show differences when utilizing different materials with jadeite showing the most variation. Of particular note are the drilling traditions of the Izumo region in Shimane Prefecture as well as a north Kyushu workshop tradition which is shared with the Korean peninsula during the Yayoi period and possibly continues on into the Kofun period further south in Miyazaki Prefecture. Although tapered metal drilling dominates during the Late Yayoi to the Kofun period, there were examples of beads which were stone drilled and likely heirloomed for centuries before being deposited in tombs.

The provenance of chalcedony beads in Jirzankal Cemetery of Pamir Plateau

Meiting Yan, Xinhua Wu, Zihua Tang

The Jirzankal Cemetery on the Pamir Plateau dates back about 2,500 years, and numerous artefacts have been unearthed, including carnelian beads. These beads are diverse in color and morphology, while the existing research mainly focused on their morphological classification and description. The chemical composition and provenances of the carnelian beads remain to be further explored.

We here determined the elemental compositions of chalcedony beads using the LA-ICP-MS approach and described the compositional characteristics based on statistical analysis.

The element composition of carnelian beads in Jirzankal Cemetery was then compared with the known source of carnelian in Asia to trace their source.

Our data statistically support that the carnelian beads from the Jirzankal Cemetery may have originated primarily in the Indus Valley. In addition, the composition of a few

samples differed from that of the known sources, suggesting the need to strengthen the investigation of the carnelian source and build a database with broader coverage.

Red and black paints on prehistoric pottery of southern Russian Far East:
archaeometric study

Irina S. Zhushchikhovskaya, Anastasiya A. Lazina

This topic considers the results of an examination of painted pottery from prehistoric sites of Primorsky region (southern Russian Far East) in northwestern part of Sea of Japan basin, neighboring to Northeast China and Korea peninsular. Red-painted and black-painted ceramic wares are occurring here only in the remains of Yankovskaya archaeological culture dated to the 1st mil. BCE. Red painting looks as colored surface coating, and black painting is represented by very simple drawn patterns. Until recently painting decoration have not studied intendedly. Objects of our investigation are small series of red-painted and black-painted ceramic fragments originated from several archaeological sites within Yankovskaya culture occupation area. The methods of archaeometry were applied to research materials: optical microscopy, SEM-EDS, and Raman spectroscopy. As a result, the data on characteristics of texture and composition of red and black paints were obtained. The both are determined as pre-firing paints. Red paint is of mineral origin. It is interpreted as clayish substance mixed with ochre-like pigment containing the hematite as coloring agent. Black paint is carbon-containing of organic origin. Two kinds of composition are distinguished. One kind is based on black (amorphous) carbon, probably, of plant origin. Another kind of black paint contains the ivory black, or burnt bone, as colorant. Presented materials are considered as new evidence of pottery paints technologies in the prehistoric Eurasia.

New behavioral insights from the late Upper Paleolithic Shizitan 29 open air site
(Shanxi, China): a techno-functional approach to the archaeomaterials

David J. Cohen, Stefano Grimaldi, Fabio Santaniello, Yanhua Song

The Shizitan 29 site provides abundant, well-dated, and spatially-controlled archaeomaterial data concerning the early stages of the development of microblade technology on the North China Loess Plateau. The site sequence of eight cultural layers begins ca. 28 ka cal BP with a typical Early Upper Paleolithic advanced core and flake assemblage, also containing bone needles, stone grinding slabs, and ostrich eggshell beads. Having been invented elsewhere, microblade pressure production technology appears at Shizitan ca. 26 ka cal BP in the upper part of Layer 7, during the Late Glacial Maximum. Our application of a techno-functional approach to the lithic assemblages layer-by-layer shifts knowledge-building from traditional typologies implicit understandings based on limited and arbitrary morphotypes to more wholistic, behaviorally-oriented understanding based in considerations of raw material, entire reduction sequences, and the technical objectives of each stage of production. For microblade technology, we illustrate the necessity of emphasizing the required pressure production of blades, and we highlight some of the outcomes of our approach, including a number of newly-recognized technical features of production, such as two recurring blade-scar sequences, a particular treatment of the striking platform (which we label the 8-like contour) that likely relates to fixing the core in a holding device, and, late in the sites occupation, standardization of the blade production sequence. From these, we can argue that the evolution of microblade cores from so-called semi-conical cores to boat-shaped cores is an adaptation to maximize the efficiency of production of regular blades with a straight profile. Lastly, if the Shizitan techno-functional approach is adopted across other sites, it could add much-needed behavioral dimensions and new insights for understanding the knowledge-sharing, communications networks, and other factors involved in the developments and wide-ranging dispersals of microblade pressure production.

Section 10

Analyses of sensory impression factor structures of middle Jomon potteries as formative artistic works

Haruhiro Fujita, Toru Miyao, Kaner Simon

Despite of the solo cooking purpose of pots in Middle Jomon potteries in ancient days, those exhibited archaeomaterials in museums are significantly attracting visitors, as sensory impressions of Jomons seem different from other potteries excavated in other archaeological eras.

18 Middle Jomon pots of Areas of Niigata Prefecture in Japan, approximately 3,000 B.C. including the Flame pots, represented in 3D by the Mixed Reality, using the Microsoft HoloLens, were examined by the Semantic Differential (SD) Methods with 16 pair adjectives. The Factor Analyses and the Principal Component Analyses were conducted, to extract the sensory impressions of modern people on archaeomaterials as formative artistic works.

Those SD adjectives are 1. beauty (beautiful -- ugly), 2. pleasure (pleasant -- unpleasant), 3. likableness (likable -- repugnant) 4. lightness (light -- heavy), 5. cheerfulness (cheerful -- gloomy), 6. excitement (excitable -- calm), 7. dynamism (dynamic -- static), 8. gaudiness (gay -- sober), 9. powerfulness (powerful -- feeble), 10. excitement (excited -- calm), 11. strength (strong -- weak), 12. hardness (soft -- hard), 13. smoothness (smooth -- rough), 14. tension (relaxed -- tense), 15. sharpness (blunt -- sharp), 16. delicacy (delicate -- rugged).

The factor analyses indicated three latent factors of human sensory impression on Middle Jomon potteries, i.e., "activity", "power" and "sharpness". The latent factor of "activity" is derived from "dynamism", "excitement", and "activity". The latent factor of "power" is derived from "powerfulness", "violent" and "strength". The latent factor of "sharpness" is derived from "hardness", "gaudiness", "roughness", "tension" and "sharpness".

Different from other non-Jomon potteries, which tend to show impressions of calmness, passiveness, relaxation and delicateness, the Middle Jomon pots indicated almost opposite sensory impressions of excitement, dynamism, activity, tension and sharpness, which attract modern people as formative artistic works, not common in other archaeomaterials.

Geometric morphometric quantification of East Asian pottery standardization: a comparative case between Yayoi funerary vessels, Japan and Erlitou Deep-Bellied Jars, China

James Frances Loftus III; Yang Bai

Pottery standardization is a crucial aspect of pottery research; encompassing various attributes such as size, raw materials, and shape to illuminate notions of state formation, social learning strategies, and changes in production methodologies. While quantitative studies on size and raw materials are prevalent, quantitative analysis of shape attributes remains scarce in East Asian archaeological discourse. This cross-cultural study aims to address this gap by employing Geometric Morphometric (GMM) analysis methods to quantify the standardization of pottery shape attributes and explore the application of quantifiable, reproducible analysis of ceramic shape.

This study focuses on two case studies: early Yayoi period funerary vessels from the Fukuoka Plain, Japan, and deep-bellied jars from the Erlitou site, China. By utilizing Elliptical Fourier analysis, this research investigates changes in shape standardization within different pottery production systems and socio-cultural contexts. Results highlight the effectiveness of 2D outline-based geometric morphometric analysis as a reliable, quantifiable approach for examining the standardization of pottery shapes within an East-Asian archaeological context.

Highlighting the significance of adopting modern statistical techniques in East Asian archaeology; this study emphasizes the necessity of expanding quantifiable

methodology in the study of archaeological materials to overcome subjective bias in the study of shape. By shedding light on the standardization of pottery shape attributes, this research contributes to a comprehensive understanding of pottery production standardization processes and associated socio-cultural implications in East Asian archaeology.

Development of a digital image restoration method using decorrelation stretch and CycleGANs for cultural properties and archaeomaterials

Kazutaka Kawano, Haruhiro Fujita, Masatoshi Itagaki, Ryo Yamamoto, Toshiki Takeuchi, Haruhiko Ochiai

Cultural properties and archaeomaterials are subject to fade and deterioration due to various causes, such as irradiation energy of ultraviolet and infrared rays, decompositions of organic matters caused by changes in temperature, humidity and water, and deposition of dust and other foreign matters on the surface of works.

CycleGANs, an extension of the Generative Adversarial Network (GAN) architecture that involves the simultaneous training of two Generator models and two Discriminator models, is able to generate an unfaded latent image of the original paintings or scripts, archaeomaterials, using the current faded images of an article, and unfaded images of the same type cultural properties or archaeomaterials, simultaneously. Two sets of GANs, where each network has a Generator who translate an image to another, and a Discriminator, who discriminates the translated image as plausible one, both Generator and Discriminator work adversarial each other.

Images of paper gold scriptures, namely Konshi Kinjikyō of Tokyo National Museum, produced in 1140 A.C. (Heian Era), of which gold mud had been washed away due to rainwater, were processed by Decorrelation stretch to enhance faded graphical lines and Chinese characters. The pre-processed images were input into CycleGANs, with images of other articles which kept the original colors very well

simultaneously, resulted being able to restore sutras and Buddhist paintings written on the paper significantly, where the deteriorated articles are difficult to distinguish with the naked eyes. This method can restore images of faded cultural properties and archaeomaterials without burdening or costing them, and will serve as a technological foundation that greatly contribute to research and utilization of such articles.

Deep convolutional classification and clustering analyses of Sue Wares on types and dating using 3D-RGBA 128*128*128 voxel data

Ryo Yamamoto, Haruhiro Fujita, Ayaka Nagumo, Kenta Ichikawa

49 and 59 samples of upper/bottom parts of Sue wares of 6th centuries in Japan, collections of the Tokyo National Museum, were optically scanned and converted 3D-RGBA 128*128*128 voxel data sets for a series of deep learning analyses.

After a data expansion, classifications in types and dating were performed using a multi-head and multi-task 3D-2D-Convolutional Neural Network model, and confusion matrices were evaluated. The accuracy ratio for the types was 53.8%, and that of dating was 69.2% respectively. As the data number of each type and dating class seemed affecting those accuracies, an improved model with Weighted Categorical Cross Entropy in the loss functions of the model was applied and contributed to accuracies of 58.7% for the types and of 71.2% for the dating. The same datasets were also analyzed by a pseudo label supervised learning model followed by a Principal Component Analysis and k-means method clustering model. The number of clusters of the bottom part data set was set at 6 and 7 by the Elbow method, and both 6 and 7 clusters showed a similarity in a significant cluster composed of dense -5 data and sparse -4 data of expert's classes. Those results were interpreted by scatter plots and cluster matrices. Modifications of voxel datasets reflecting entity attributes of actual sizes of those archaeomaterials and an improvement of the model by a generative AI clustering using latent space were discussed.

Dynamic documentation of archaeological excavations based on multi-source data fusion: a case study of the excavation of the 3# fossil human crania from Yunxian

Wenyuan Niu, Xuan Wang, Hanyu Xiang, Xuan Wei, Qiushi Zou, Yinghua Li,
Chengqiu Lu, Xianfeng Huang, Fan Zhang

Documenting tangible cultural heritage using 3D modeling techniques is gradually becoming an indispensable component of archaeological practice. The 3D modeling techniques enable highly realistic reproduction of sites and ruins and be proven as a powerful tool for documenting archaeological excavations. However, dynamic recording an ongoing excavation using 3D modeling techniques is still considered tedious, time-consuming, expensive, and dependent on expertise. In these senses, documenting the archaeological excavation at the Yunxian Human site (located in Hubei, China) is a valuable opportunity for exploration and practice. In 2022, the Yunxian Human site unearthed the most intact fossilized contemporaneous ancient human crania ever found in the Eurasian interior, preserving important and scarce anatomical features of this phase of humanity. We performed a dynamic documentation for the ongoing archaeological excavations, and focused on improving spatial resolution, time-resolved, and efficiency. This high-profile archaeological excavation project prompted us to pursue several new methods and an efficient workflow, which we present in this paper to provide a state-of-the-art practice.

Archaeomaterial image restoration of Oyu stone circle's sundial-shaped stones, by
CycleGANs

Haruhiro Fujita, Toru Miyao, Masatoshi Itagaki, Yoshito Hanami, Tomomi Akasaka,
Ryo Kinouchi, Primitiva Bueno Ramirez

Oyu stone circles were built at a ritual site on a terrace along the Oyu River, Kazuno City, Akita Japan in 2000 B.C. Most of the stone circles were made by arraying

river stones, including sundial-shaped stones. The majority material (more than 60%) is quartz diorite collected from the middle streams of the Oyu River and the Akutani River, a tributary of the Oyu River.

The archaeomaterial significance of the color tone restoration of the Oyu's sundial-shaped stones is to provide evidence for examining the possibility that ancient people in Oyu had specific color tone preference, by representing the original color tone of the mother rocks of those sundial-shaped stones by the deep learning methodologies. Those sundial-shaped stones were after excavation exposed to sunlight and rain, and the upper surfaces and northern directional faces are suffered by biological damages and difficult to identify original color tone. The CycleGANs (Cycle Generative Adversarial Networks) were applied to represent the original color tone on the sundial-shaped stones, while preserving the geometries of the original stone surfaces. Those networks have two sets of Generators and Discriminators setting the weathered original stones as A image domain, the river bed stones as B image domain, work adversarial in the two networks.

Modification in the learning rates of the Generator and the Discriminator of the model was conducted, and the range of 2.0×10^{-2} - 2.0×10^{-3} of the Generator and those of 2.0×10^{-4} - 2.0×10^{-5} for the Discriminator brought the best segmentation of those original stones as well as transforming the color tone of the river stones.

It was proved that CycleGANs were the efficient restoration methods to represent the weathered stone images to plausible river bed stone color tone. Trials of 3D reconstruction of the sundial-shaped stone using the Cycle GANs were conducted.

Section 11

Japanese state formation and sue stoneware production: a morphological case study of the Northern Kyushu Region

Yuki Adachi

The 6th-7th centuries mark the crucial period of state formation throughout the Japanese archipelago. This study explores how state control over handicraft production during this formative period extended across various regions, with a focus on Sue ware production.

Sue ware, a type of stoneware, saw significant advancements in techniques and styles primarily originating in central regions where state institutions were being developed. These innovations later disseminated to other areas, resulting in a distinct stylistic commonality across Sue ware distribution. However, regional characteristics also emerged. This study focuses on the morphological changes of dishes with fitted lids, and examines whether differences in the transmission of information and technology existed among kilns within a given region. If morphological changes align with those in the central region, a close relationship between the production group and the central region can be inferred. Conversely, stronger regionality in morphological changes implies production occurred with minimal control from the central region.

With a focus on the northern Kyushu region, this research examines major kiln sites through morphological analysis of pottery. Tentative findings reveal two distinct types of kilns: Type A, adhering to the latest central style, undergoing relatively smooth changes; and Type B, characterized by traditional local forms and techniques. Type A kilns indicate strong control from the central region, likely associated with local rulers who held fictive kin-relationships with clans belonging to the central regime. In contrast, Type B kilns suggest a group of handicraft producers aligned with a powerful local clan, conducting production as a service to their influential local clan leadership.

This study provides valuable insights into the dynamics of state formation by examining the transmission and control of handicraft production in the context of Sue ware, contributing to our understanding of the broader processes shaping early Japanese state formation.

Yu Ding

Chinese ceramics contain art elements of diversification. As one of the most important commodity for exporting in ancient time, Chinese ceramics were popular around Indian Ocean from 9th century. When the ceramics reached the coast of the Indian Ocean, the function of its cultural and artistic connotation changes a lot. The interesting discussion is focus on how the process of localization happens.

East African coast is an important part of western trade circle of Indian Ocean. It is also the region which have found the most Chinese ceramics shards in Africa. There is a kind of tombs for nobility who have great pillars before the tomb. The special phenomenon is that there are always Chinese ceramics ornamented the pillars or the tombs. In my opinion, tombs are the results of ritual activities, which always have special meaning for the local people. The situation that Africans taken Chinese ceramics as the decoration of their tombs, may means that Chinese ceramics were given specific mental meanings in the society of East Africa. How it happens? Based on the archaeological materials from Mambrui and Malindi in Kenya, I will try to analyze the function of Chinese ceramics in the society of East Africa, the artistic feature of Chinese ceramics, and the construction of the pillar tombs in the two sites, to illustrate the cultural role of Chinese ceramics in the society of East Africa.

Production industry of lead-glazed potteries in the Middle and Late Tang

Siya Chen

Many scholars consider that the lead-glazed pottery production industry declined in the Middle and Late Tang dynasty. Although those artifacts remarkably decreased at tombs, quite a few were found in city sites, such as the two capitals of Tang Chang'an and Luoyang. Additionally, more kiln sites that produced lead-glazed potteries emerged in this period and showed various production techniques than the previous time of Flourishing Tang. This presentation mainly focuses on the products, kiln

furniture, and molds from kiln sites to study the category and decoration of products, production techniques, and production organizations in different kilns. Moreover, to discuss the circulation situation in different areas, comparing the above distinctions of those kilns with categories, ornaments, and production marks of artifacts in cite sites. In addition, the historical background regarding local interaction in culture and production will be examined through different appearances relating to the production and circulation of kiln sites.

Tile ends with lotus patterns unearthed from the Mengzhuang Kiln Site in Yecheng:
focusing on the tile-end production techniques with wooden molds

Meng Lyu

Tile ends, which are forward ends of curved roof tiles on eaves, found at the Mengzhuang Kiln Site in Yecheng prove that the appearance of tile ends with lotus patterns in Northern China can be dated back to the periods of the Sixteen Kingdoms (304-439 AD). They may have an influence on the similar style tile ends found in Pingcheng of the Northern Wei Dynasty, which were made at the end of the 5th century and are considered to be the origin of the tile ends with lotus patterns used in the Northern Dynasties and the Sui-Tang Dynasties.

This presentation consists of two main parts. First, it shows the achievements of the preliminary research on these tile ends, including their style, size, and production traces left on tile ends surfaces. Through analyzing these data and traces, we recovered the production techniques of these tile ends and found that the tile ends unearthed from the Mengzhuang Kiln Site were made in wooden molds, which was different from the tile ends of the same area after the 5th century that were mostly made in ceramic molds. This implies that they may have a close association with the tile ends found at sites in Southern China. Second, we talk about the transmission of both styles and techniques of tile-end production from the southern part to the northern part of China, treating Yecheng of the Sixteen Kingdoms as a relay node on the transmission route.

The construction of huge cities in China early medieval period improved the development and transmission of production techniques of building materials. The tile ends unearthed from this site give us some clues regarding this process.

Scientific investigations of Tang Dynasty pottery figurines

Benedetta Vitale, Eliano Diana, Angelo Agostino, Marco Guglielminotti Trivel,
Carolina Orsini

The Tang Dynasty (618-907 CE) was a period of prosperity that favoured the boasts of the largest volume and variation of the burial terracotta figurines called mingqi (spirit objects).¹ According to the international exchanges along the Silk Road, these statuettes reflect the high level of cosmopolitanism since they vividly depict exotic characters as musicians, vibrantly painted horses, entire teams of polo players, and Bactrian camels.

From the XIX century, the West's fascination with the East exploded, and the mingqi figurines became highly admired by European collectors. Consequently, modern reproductions of Tang-style statuettes proliferate in the Western art market. Nevertheless, little provenance information is available, and the authenticity is often uncertain. Moreover, there is a relevant knowledge gap about materials and manufacture for large-scale production.

Here we present the pilot archaeometric study of Tang-style figurines of uncertain authenticity stored in the major European museum and private collections.

A multi-technique and multi-scale approach has been established to investigate ceramics related to museum contexts. First, the analyses are based on non-invasive techniques, like fibre optics reflectance spectroscopy (FORS) for the characterization of the peculiar three-coloured glazed terracotta (sancai). When the micro-sampling is allowed, the fragments are deeply characterised by a combination of laboratory microscopies and synchrotron micro-analysis (μ XRF, μ XRD, μ XANES).

This methodology allowed for maximizing the analysis performed on the same sample and obtaining complementary outcomes from the different techniques. The early results led to getting insight into the manufacture of these intriguing finds and might have significant importance for the next authenticity and provenance studies of Chinese artefacts stored in European contexts.

Section 12

The early pottery traditions on the Pacific Ocean coast based on materials of the
Russian Far East and Ecuador

Lazina Anastasia

The report is based on the results of investigation of the Neolithic early ceramics from the archaeological sites of the Russian Far East and Ecuador. We conducted the study of 4 ceramic complexes. The ceramics of the Boismanskaya culture (Russia) and San-Pedro complex (Ecuador) is made by hunter-gatherer societies. The ceramics of the Zaisanovskaya culture (Russia) and Valdivia (Ecuador) is used by societies of the early farmers. The goal of our investigation is to conduct a comparative analysis between them. The results demonstrate some differences in making molding mass, decoration and firing process. The functions of pottery are different, too. The pots of the hunter-gatherers were used for cooking, and ceramics had simple forms and ornaments. The structure of farmer societies is more complicated. They used pottery for cooking and rituals. The pottery decoration for rituals had a sophisticated design and unusual form. All the complexes demonstrated a high level of skills in pottery production. Thus, the cultures of the regions that are far from each other has similar traditions of pottery production.

Pottery production and circulation in the Liangzhu Site complex during the late
Liangzhu Period: preliminary results

Mi Wang

Although Liangzhu's black-skin pottery, known as, unquestionably exhibits a remarkable level of pottery craftsmanship for the prehistoric era, its production and distribution context remains uncertain. This study tries to determine whether specific production centers were responsible for crafting this distinct pottery type or if local potters created imitations. Furthermore, the author seeks to explore whether the circulation network of black-skin pottery differed from that of non-black-skin pottery. Did black-skin pottery undergo centralized production and distribution to other regions, while non-black-skin pottery was predominantly made and used locally? To investigate these questions, the author employs a combination of petrographic and chemical analysis to cluster pottery groups based on compositional differences, which correspond to distinct production events. By comparing these pottery assemblages and examining the similarities or differences in the proportions of pottery groups, we can shed light on the circulation networks of these ceramics. This research project aims to explore, ultimately, human relationships within the Liangzhu site complex during the late period: how the inhabitants of the Liangzhu site complex produced and acquired their pottery at a regional scale; additionally, how pottery networks evolved within the context of emerging settlements on walls and an expanding urban center at a local scale. This presentation presents the preliminary results of the pilot study, focusing on microscopic and pXRF analysis conducted on the pottery samples.

Petrographic and chemical analyses of the Late Neolithic Period pottery from the
Lushanmao site in Shaanxi, China

Nani Liu, Mingzhi Ma, Kunlong Chen

Lushanmao is an important late Neolithic site for the research of the early China, which is in Yan'an City, Shaanxi Province. The central area Dayingpanliang was excavated during 2016 to 2018. It's a high-level architectural complex, there were discovered some clay tile and pottery sherds. In order to know how to make them and make a comparison, the study used various methods, such as XRF, SEM-EDS, FTIR, polarizing microscope.

Research shows there is no significant difference in raw material selection, processing and firing technology between the pottery and tile. All samples divided into five petrographic groups, which consists of two kinds of clay and several kinds of inclusions. Mostly used the fine silty clay, only two made by very fine clay, Inclusions divided three categories, such as mudstone plant and feldspathic quartz mineral, the latter divided granite, gneiss, sandstone.

Paleosoil should be the main source of clay. The granite obtained from river, the mudstone and sandstone obtained by crushing rocks. The gneiss may be the proof of obtaining raw materials at a distance. Plant leaves are added directly to clay rather than burned to use.

Almost tile and pottery were fired in 700-800 in reducing atmosphere little in 900. Judging from results, there was no specialization in tile production in Lushanmao, Besides, both tile and pottery are mainly produced locally, with the possibility of remote exchange, which may be related to the status of the core area.

Material characterization of potteries from the Zhengzhou Shang City

Ke Yuan, Shugang Yang, Siran Liu

Zhengzhou Shang City is a large-scale Erligang period archaeological site and widely accepted as the capital city of the Early Shang Dynasty. This research, for the first time, conducted detailed material characterization of pottery fragments from this site. Samples are from two excavation areas within the inner city wall, Confucian

Temple site and Xiyanglou site, and can be dated to both the lower Erligang and Upper Erligang periods. Petrographic and XRF analyses show that they can be divided into six fabrics on the basis of varied mineralogical and chemical compositions. Both alluvial clay and loess/paleosol were found as raw materials for pottery manufacturing. Two types of tempers, rock fragments and river sand were used. Additionally, Fabric F1 was made with a high alumina clay and Fabric F2 used calcareous clay. They were considered as imported since these materials are rare in local geology and there were only a few fragments were identified to be F1 and F2. A number of diachronic patterns were revealed. First, loess/paleosol was commonly used in the lower Erligang potteries but sharply decrease in the Upper Erligang potteries. Meanwhile, rock fragment temper also become less common in the Upper Erligang period. The material characteristics of potteries become significantly more homogeneous in the Upper Erligang period. It is also noted that the potteries made with loess/paleosol and rock fragment temper are frequently associated Erlitou and Yueshe styles. It's argued that at the beginning of the Shang Dynasty (low Erligang period), pottery production in the Zhengzhou Shang city was decentralized and varied cultural group might obtain potteries from different workshops. This pattern greatly changed in the Upper Erligang period when the alien style potteries became rare and pottery making material more homogeneous. This find may shed new light on the social reformation process of the early Shang period.

Exploring raw materials and technological choices in Neolithic pottery production: a case study of Majiayao-style pottery in Northwest China

Evgenia Dammer, Anke Hein, Michela Spataro

The Neolithic Majiayao-style pottery belongs to the manifold prehistoric painted pottery styles identified in northwest China. The fine painted Majiayao style consists of distinctive black and red designs and has been the subject of extensive typological studies and discussions of relative chronologies. Rarely included in these typologies is the coarse pottery ware decorated with cord markings, but which is found in the same

context as the painted pottery. Recent research focusing on the technological aspects of pottery production was able to enrich our understanding about the prehistoric technological knowledge by studying both types of wares through petrography and comparisons with geological materials.

This paper focuses on the investigation of raw materials for pottery production conducted through a geological survey around the Majiayao type-site in the Tao River Valley. The research aims to assess the natural variation of raw materials by collecting clays in their natural state and investigate the technological choices in prehistoric paste recipes and firing technology. This study emphasises the importance of integrating geological and technological factors for a comprehensive understanding of prehistoric ceramics. Lab-based analyses, such as macroscopic analysis, optical microscopy, and SEM-EDX, were conducted on geological samples. The collected data was then contextualised and interpreted in a comparative study with the archaeological pottery providing insights into the actual choices made by prehistoric potters.

The results of the analyses revealed previously unknown details about the Majiayao-style pottery production which were only possible by including both coarse and fine Majiayao pottery as well as geological samples collected in the study area. This research contributes to understanding the interplay between raw-material availability, technological practices, and decision-making processes in pottery production during the Neolithic period in northwest China.

Keynote 3

The study of organic materials used in cultural heritage

Shuya Wei

In order to preserve cultural heritage, the knowledge of the chemistry of the degradation of natural organic materials and the identification of the materials used in the objects are of main importance. The common binding media used in cultural

heritage include oils, proteinaceous materials, resins, lacquer and waxes etc.. The unambiguous identification of binders is a challenge due to various reasons. Among these are: the deterioration of the original materials as a result of natural ageing and degradation due to environmental effects; the complexity of natural organic binding media, particularly if mixtures of different substances are used, and the small amount of sample available. The main techniques used for organic materials analysis are gas chromatography/mass spectrometry (GC/MS), Pyrolysis gas chromatography/mass spectrometry (Py-GC/MS), High performance liquid chromatography/mass spectrometry (HPLC/MS), Fourier transform infrared spectrometry (FTIR) and near infrared spectrometry (NIR). Especially thermally-assisted hydrolysis and methylation pyrolysis gas chromatography/mass spectrometry (THM-Py-GC/MS) is widely used in the identification of organic materials nowadays due to its simple sample preparation and high sensitivity. In addition, this technique can be used to identify multi-materials in a single analysis, which is crucial for the cultural objects, which are demonstrated in the case studies. Quantitatively analysis by Py-GC/MS still remains a problem. Further studies need to be considered in the aspects of sample preparation and data evaluation. Other methods such as FTIR, NIR etc. can be combined with Py-GC/MS to achieve qualitative and quantitative analysis.