

Glass between cultures

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For millennia, glass has inspired artists and given a medium of cultural expression, as well as exchange between cultures. Its unique properties make it most suitable for long-distance transport, while the magic involved in its making provides unparalleled evidence for the role of craftspeople in transferring the particular skills to make glass in a specific manner.

In this talk I will be exploring the evidence for the exchange of glass and related know-how in the Late Bronze Age eastern Mediterranean, in the Roman and later period between the West and the East, and reference a unique case of glassmaking in West Africa. The overall question is how the material glass by itself can travel and result in very different technical and cultural responses compared to the movement of actual glassworkers.

Glass and glassmakers in Late Bronze Age Egypt.

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Egypt's role in the production of glass in the Late Bronze age has been a topic of debate for many years. The first reports of late 19th Century scholars believed glass to be an Egyptian invention, although we now have evidence that suggests that glass was first produced in the Near East. W.M. Flinders Petrie, who excavated at a number of sites in Egypt and extensively at Amarna, suggested that glass was at least produced in Egypt from the time of Akhenaten (1352-1336 B.C.) based on his findings at the site. This supposition, although originally challenged, has now found support more widely with new finds from excavations and the use of increasingly sophisticated methods of analysis applied to ancient glasses.

This paper will review some of the evidence for early Egyptian glass, using a few specific artefacts as examples, to illustrate the new advances in our understanding of the development of Late Bronze Age glass in Egypt.

The exchange, production, and use of glass beads and artifacts in Southeast Asia from the Iron Age to the post-Angkorian period

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This paper will review and summarize current evidence for the exchange, production, and use of glass beads and artifacts in Southeast Asia covering approximately two millennia. I begin with a discussion of the earliest appearance of glass beads and jewelry (bracelets, rings, and earrings) during the Iron Age period (approx. 500 BCE – 500 CE), which is often taken as material evidence for contact with South Asia. Recent compositional work by the author and other scholars has identified several types of glass recipes used to produce beads and artifacts that were circulating on different exchange networks that shifted over time and space. The author has argued that some of these fluctuating trade networks might be related to the growth of an early state level society located in the Mekong Delta region.

In addition to the exchange of beads, there is also evidence for the production of glass beads at several locations in Southeast Asia. I will review some of this evidence and tie these possible production locations into the broader exchange networks observed by the distribution of finished products. As most glass objects have been found in burials, I will also review some patterns in the distribution of glass beads at different sites that might tell us about the status of individuals who used and wore these beads.

Over the course of the first millennium CE, burial rituals in mainland Southeast Asia changed. Fewer people were buried in inhumation burials with grave goods, which have resulted in the discovery of fewer glass beads. However, recent work at two Angkorian period sites has identified glass beads and objects in non-burial contexts associated with elites. Work by the author and others have identified the glass recipes at these sites that show connections to glass production centers in China and the Middle East. There are also similarities to glass beads and objects in circulation at other maritime sites in Southeast Asia. Although the purpose of the glass beads is unclear, I will propose some ideas about how these beads might have been used.

Lastly, I will discuss glass beads associated with post-Angkorian (15-17th century CE) upland communities in Southeast Asia. Glass beads were found within jar burials in Cambodia's Cardamom Mountains, which show connections between these people and maritime trade networks in Southeast Asia. I will also share preliminary work on

heirloom beads found in more recent upland communities of mainland Southeast Asia. These later examples show the continued importance of glass beads to certain communities within Southeast Asia.

Overall, this paper aims to summarize the broad patterns of exchange within Southeast Asia as reflected through the glass artifacts as well as changes in how glass beads were used by people over time.

台灣鐵器時代早期玻璃珠的區域與時間分佈

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進入鐵器時代後，台灣的考古遺址開始出現許多玻璃珠。這些珠子大多是單色珠，直徑約 1mm。他們的出現引發了許多討論，特別是關於他們與東南亞的關聯性，以及當時玻璃珠在台灣島內的交易的議題。因此，此研究透過分析這些鐵器時代早期出土的玻璃珠的異同，討論這些珠子與環南海交易圈的關係，以及所反映的台灣島內的玻璃珠交易與互動。

此研究分析了 5 個遺址的玻璃珠樣本，包含淇武蘭下文化層、舊香蘭、龜山、道爺以及五間厝，此外，西寮遺址和十三行遺址已發表的資料，也將納入討論。除了形制分析之外，也使用了 SEM-EDS、EPMA 以及 LA-ICP-MS 進行科學分析。這些遺址涵蓋了廣大的地理區域，以及約西元一千紀左右的年代範圍。

研究結果顯示玻璃珠的形制或化學成份都存在區域或年代的差異。由化學成份來看，礦物鈉鋁玻璃和植物灰玻璃是最常見的兩種化學成份，整體而言，比較早期的遺址(如：舊香蘭、道爺)的礦物鈉鋁玻璃的比例較高，比較晚期的遺址(如：西寮、淇武蘭)的植物灰玻璃的比例比較高。這個結果與環南海一帶的玻璃化學成份的年代趨勢是相符的：在西元一千紀早期，主要是礦物鈉鋁玻璃，在晚期則主要是植物灰玻璃。然而，微結構分析的結果，卻顯示不同遺址的玻璃珠來源可能不盡相同，特別是此次分析的台灣東南部的玻璃珠樣本。

研究結果也顯示，在台灣北部與東北部的玻璃珠，顏色分布與形制有明顯的不同，特別是其中一類有橘色玻璃外皮的珠子(坯體為玻璃或陶土)，目前僅在這個區域發現，並且這個地區的玻璃珠顏色以橘色和藍色為主。在東南部和南部的遺址，玻璃珠的顏色比較多元，包含紅、橘、黃、綠、藍等，珠子的外形比較圓。在西南部的遺址，珠子的邊角比較明顯，而顏色分布隨著年代有所差別，這些差別可能同時也反映了不同年代之間，玻璃珠顏色與化學成份存在一定的關聯性。

整體而言，這些結果顯示在西元一千紀時，台灣鐵器時代的玻璃珠來源與環南海交易圈有密切的關係。但是，此次分析所見的區域性分布，可能也說明當時台灣島內並沒有頻繁且大區域的玻璃珠交易。這可能進一步顯示當時台灣島內以及與環南海之間的多尺度的區域互動，同時也為不同區域與社會之間的經濟與社會政治互動的研究，提供更多的研究空間。

The regional and temporal distribution of glass beads in early Iron Age Taiwan

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During the turn of the Common Era, the early Iron Age Taiwan witnessed the emergence of glass beads in archaeological record. These beads are mostly monochrome, with a size of around 1 mm in diameter. The presence of these tiny beads has raised the discussion in terms of their connections to Southeast Asia and the exchanges in Taiwan. This research therefore aims to understand the differences and similarities of glass beads in early Iron Age Taiwan and to investigate the exchange within Taiwan and the relationship to the South China Sea network.

This research analysed glass beads from five Iron Age sites, Kiwulan, Jiuxianglan, Guishan, Daoye and Wujiancuo in Taiwan, and the published data from two sites Shisanhang and Xiliao were also included for comparison. This covers a wide geographic range of northern, northeastern, southeastern, southern and southwestern Taiwan, and a chronology spanning over the 1st millennium AD. Typological studies were firstly carried out, followed by SEM-EDS, EPMA and LA-ICP-MS to understand the chemical composition and microstructure.

The results have revealed the temporal and regional distribution of glass beads, in terms of both typology and chemical composition, in Taiwan in the 1st millennium AD. m-Na-Al glass and v-Na-Ca glass (plant ash glass) are the two common chemical groups. In general, higher proportion of m-Na-Al glass was found in early dating site such as Jiuxianglan and Daoye, and an increasing proportion of v-Na-Ca glass is seen in later sites such as Xiliao and Kiwulan. This result echo the temporal transition seen in the South China Sea network, with the dominance of m-Na-Al glass in early 1st millennium AD and the v-Na-Ca glass in late 1st millennium AD. However, microstructural investigation of the m-Na-Al glass has further revealed that the glass beads might not be imported from a single source, in particular those from southeastern Taiwan.

It is noted that the colour and typology of glass beads from northern and northeastern Taiwan show distinct differences. In particular, a type of bead with

orange surface and clay/glass-made body is only found in northern and northeastern Taiwan, and the common colours of glass bead are orange and blue in this region. Glass beads from southern and southeastern Taiwan display a diverse range of colour including red, orange, yellow, green and blue, with a more rounded shape. Beads from southwestern Taiwan exhibit a more tapered edge, and a differentiated colour distribution between sites, possibly associated with the chronological transition of chemical composition mentioned above.

Taken together, these results suggest that the import of glass beads in Taiwan in the 1st millennium AD is highly associated with the South China Sea network. However, the regional differences seen in the chemical composition and typology do not show intensive bead exchange between different regions in Taiwan. This suggests a multi-scalar interaction within Taiwan and between Taiwan and the South China Sea network, and highlights further research potential of economic and socio-political interaction between regions and societies.

Ancient Japanese glass imported from Eurasia as revealed by on site XRF analysis.

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Since glass is a synthetic material made by mankind, its chemical composition contains archeologically important information such as manufacturing period, manufacturing area, and manufacturing method *etc.* Glasses can be divided into several types depending on their chemical composition and information on the origin of the glass can be obtained by analyzing the glass. Since ancient glass is a valuable cultural property, a non-destructive analytical methods are often required in the analysis of glass such as X-ray fluorescent (XRF), EPMA, and LA-ICP-MS analyses. The authors developed a portable XRF spectrometer capable of quantitative analysis of Na and Mg, which are important composition of glass, and have analyzed a large number of glass at museums and excavation sites.

The origin of the glass was known as West Asia ca. 4000 years ago, and then gradually spread the Eurasian Continent. In particular, after the glass blowing technique was invented in Syria in the 1st century BC, glass was produced in large quantities as living necessities, and along with the expansion of the Roman Empire, it spread throughout the Asia through the Silk Road. It is said that glass spread to Japan around BC 3 C, and a large amount of glass beads are excavated as burial goods from the ancient tomb. Japan is geographically located at the end point of the Silk Road, and by examining the glass in Japan, you can learn the transition of glass in East Asia. The authors continue to analyze ancient glasses excavated in various parts of Japan from Hokkaido in the north to Kyushu in the south with the portable XRF spectrometer. In addition, we brought the XRF to China, Vietnam, India, Russia, Kyrgyzstan, Tajikistan, Turkey, Egypt etc., and analyzed the excavated glass to know the compositional change.

In overview of ancient glass distribution in Japan, around BC 3 C, lead barium (silica) glass and lead glass originating in China circulated, and potassium (silica) glass originating in Southeast Asia also circulated. After that, high alumina soda lime glass originating in Southeast Asia was excavated from the beginning of AD, and then soda lime glass was widely distributed to 7 C, all of which are imported. In Japan, high-lead glass containing 60-70% PbO was produced in the latter half of 7C when glass production from raw materials began. After that, in the Song Dynasty in China, a lead potash glass was developed and delivered to Japan. After that, Japanese glass is predominantly made of potash lead glass, and it continues to the Edo period.

Meanwhile, potash lime glass produced in China in Song Dynasty were distributed in medieval Japan. It is noted that due to the influence of isolation policy there was little variation of chemical composition of glass in the Edo period. However, in Hokkaido, glass is appreciated in the Ainu culture, so the distribution of potassium lime glass and potassium lead glass is observed characteristically. In the lecture, we will discuss the distribution of glass in East Asia while comparing these glasses excavated in Japan with the glasses in various regions of Eurasia.

中國古代玻璃技術的本土發展與絲綢之路上的中外交流

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古代玻璃與絲綢、金屬製品等都是探索絲綢之路上中外經濟、技術和文化交流的重要實物資料。絲綢之路的四條主要線路，即草原絲綢之路、綠洲絲綢之路、西南絲綢之路和海上絲綢之路，在與古代玻璃及技術的傳播中發揮了交叉和互補作用。通過絲綢之路傳入中國的玻璃器，在器形、製作工藝、化學成分、分佈區域等方面具有明顯的時代特點。綜合考古發掘、產地風格、地域分佈、科技分析、歷史文獻的研究結果，已能夠對不同時期、不同來源古代玻璃在沿絲綢之路的分佈有了較為清晰的認識。本文主要圍繞外來玻璃製品的客觀影響和中國古代玻璃製作技術的本土發展兩個方面進行闡述。

本文的研究物件為考古發掘所發現的春秋至東漢時期的玻璃製品，以及相關的鉛鋇釉低溫釉陶、蝕刻石髓珠、石榴子石、綠柱石等器物。這些器物分佈在中國的新疆、陝西、山西、河南、湖北、湖南、廣西、廣東等地。根據春秋戰國時期蜻蜓眼玻璃珠的化學成分體系（如鈉鈣玻璃、鉛鋇玻璃、鉛鋇低溫釉陶）、著色劑和乳濁劑（如銻酸鉛、銻酸鈣、鋇的化合物）、年代早晚，探討了陸上絲綢之路沿線的玻璃製品傳播和中外交流。基於對中國不同亞類鉀玻璃的分佈特徵和寶石、半寶石珠飾的研究，與東南亞、南亞出土的鐵器時代古代珠飾進行了比較分析，探討了漢代前後海上絲綢之路上的貿易和文化交流。鑒於古代玻璃對研究絲綢之路早期中外交流的重要指示意義，指出了今後應加強研究的幾個方向。

Native development of ancient Chinese glassmaking and the mutual exchanges between the East and West along the Silk Road

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As same as silk, metal and other artifacts, ancient glass is one kind of important materials to trace the economic, technical and cultural exchanges between China and West along the Silk Road. For the transfer of ancient glass and glassmaking technology, the four main routes of the Silk Road, that is to say the Steppe Route, the Oasis Route, the Maritime Route and the Southwestern Route, played a cross and complementary role. The glass artifacts imported into China through the Silk Road have typical characteristics of the relative times in the aspects of typology, craftsmanship, chemical composition and others. Basing on the research results of archaeological excavation, original style, regional distribution, technical analysis and historical literatures, we have obtained a better understanding on the distribution of the early glasses, which were dated to different periods and with versatile provenances, along the Silk Road. The present paper will main focus on two aspects, one is the objective effects of imported glasses from the West and the other is native development of ancient Chinese glassmaking technology.

The present research focuses on excavated artifacts of glass, glazed potteries with lead-barium-silicon glaze · etched carnelian beads, stone beads made of beryl and garnet, and so on. These artifacts were mainly dated from the Spring and Autumn period to the Eastern Han Dynasty. The covered areas include Xinjiang, Shaanxi, Shanxi, Henan, Hubei, Hunan, Guangxi, Guangdong and et al. of China. Basing on their chemical composition (e.g. soda-lime glass, lead-barium glass and glaze), colorant and opacifier (e.g. $Pb_2Sb_2O_6$, $CaSb_2O_6$ and barium-based compounds), and appearing time, we discussed the dissemination of glass artifacts and exchanges between the East and the West along the steppe and oasis routes of the Silk Road. Through analyzing the distribution characteristics of the potash silicate glasses, which were divided into different subtypes, and combining the research results about gemstone and semi-gemstone beads, we compared them with those of the Iron Age found in Southeast and South Asia and discussed the trade and cultural exchanges along the maritime Silk Road around the Han Dynasties. In view of the above - mentioned facts, we made some proposals for the following studies related to the mutual exchanges along the Silk Road related to ancient glass artifacts.

台灣東部珠飾的美麗再現：以排灣族琉璃珠的重製工藝為例

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在台灣的原住民族群中，最受到重視且與部落文化聯繫最深、蘊藏豐富多元的珠飾神話傳說當屬排灣族的琉璃珠。這些珍貴多彩的琉璃珠，無論是藉由海上貿易交換而來，或是部落藝匠的仿作，都有其獨特的寓意與族群美學蘊藏其中；大型多彩琉璃珠在台灣僅見於排灣、魯凱和卑南三族，尤其以排灣族的珠飾是用多色、細小型琉璃珠排列成各種紋樣，縫綴在黑、紅、藏青色的底布上，顯得格外高貴華麗。排灣族人藉由琉璃珠所蘊藏的故事而長存不滅，將排灣族人講究的心靈及生活層面的文化觀、宇宙觀完整流傳下來，睿智且有依據的按其神話傳說、階級分工、生命禮儀、神靈信仰及天地人觀，為每一顆紋珠命名。

因此，再現多彩珠的樣貌是近代常見的工藝技術探討，藉由物件的再現來延續故事、圖紋內涵傳遞、文化傳承的載體。本文試圖探討這些珠飾的再現模式，與探討東部工作室的重製工藝脈絡與當代重製工藝發展的狀況。

關鍵字：排灣族琉璃珠、重製工藝、珠飾神話、玻璃、陶瓷

Paiwan Glass Beads and the Contemporary Development of Recreating Traditional Artistry

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Among all indigenous art crafts of Taiwan, the Paiwan glass beads are the most valued for they are deeply linked to tribal culture and innately abundant in myths and legends related to the tradition. The precious multicolor glass beads, whether obtained through maritime trade or replicated by tribal artisans, have illustrated tribal aesthetics and bore distinctive meanings. In Taiwan, only the Paiwan, the Dreokay (Rukai), and the Pinuyumayan boast the art of big, multicolor glass beads. Paiwan artisans also arrange small, multicolor glass beads into diverse patterns and sew them on black, red and navy blue base cloth, creating a resplendent look with elegance. The myths and legends of Paiwan has been preserved and passed down through glass bead artistry which manifests the life philosophy of Paiwan at material, spiritual and cultural levels. With wisdom and in order, the people of Paiwan has named every type of beads according to their myths and legends, division of labor, philosophy of life, religious beliefs and world view.

The reconstruction of glass bead art is the reconstruction of tribal stories of the Paiwan and the artistic, cultural meanings behind them. Consequently, the techniques of recreating multicolor glass beads has become common research topics of the time. This thesis will look into the modes of replication, the craftsmanship of remaking glass beads in east-coast studios and the contemporary development of recreating traditional artistry.

淺談排灣族 qkata 琉璃文化於現代面臨的難題:以卡塔文化工作室為例

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在台灣原住民中，以排灣族的配飾與圖紋流傳與文化識別較為顯著，使用的琉璃珠飾較多，繁複的圖紋裝飾常見於身份地位較高者服飾上，其圖紋也與社會階序緊密扣連著，代表著親族與社群的關係以及神靈溝通的超自然的力量表徵。

然而，在全球文化觀光衝擊之下，部落也隨著經濟導向逐漸將具有社會地位、財富和特殊身分的文化表徵的qkata(琉璃珠)傳統工藝透過一次次的部落行銷模式，轉為觀光藝品的銷售方向走去，該如何能保留文化的獨特性？部落具盛名的風景區為了提供充足的貨源維持收益，採以進口貿易相仿排灣族傳統珠紋以低價進貨的方式，取代培育部落工藝生產者，未來是否弱化了排灣族qkata(琉璃珠)在傳統文化重要社會象徵？本文以筆者本為排灣族人並以qkata(琉璃珠)為主體的卡塔文化工作室經營為例，希望藉由現有經營排灣族傳統琉璃珠配飾面臨保存傳統圖紋意涵變遷與傳統文化表徵的延續上所面臨的難題，與眾多南島語族聚集交流的場合中，尋求思考文化形式如何維持傳統工藝所蘊含的地方自主力量，持續成為族群傳統文化的表徵與文化紀念的地位和建議解決方法。

關鍵字：排灣族、琉璃珠、南島語族、配飾

The difficulties faced by Paiwan ‘qkata’ glass culture in modern period: a perspective from Ata Beads Workshop

Kedrededr maljajaves (Hsiu-Hui Lin)

Ata Bead Workshop

The ornaments, design motifs and cultural recognition of Paiwan people are one of the most distinct among the indigenous population in Taiwan. The use of glass beads is also more common. The complicated and elaborated motifs are often seen in the clothing of people with high status, closely associated with social hierarchy, and symbolizes the connection of kinship and community and the supernatural ability to communicate with the deities.

However, with the impact of globalization on tourism and the economically-oriented policy of indigenous tribes, the ‘qkata’ glass beads, which represent social status, wealth and identity, have been gradually transformed to become souvenir items as a result of marketing strategies. Under this condition, maintaining the uniqueness of indigenous culture becomes an important issue. In addition, the tribes often purchase low-priced replica beads with similar traditional Paiwan motifs, and re-sell these beads in popular scenic spots to maintain their income. They tend not to train craftspeople in the tribe. The question then is, would such strategy weaken the social significance of qkata (glass beads) in the traditional Paiwan culture? In this article, the author, an indigenous Paiwan, used Ata Bead Workshop as an example to discuss these issues. By presenting the changes in the meanings of traditional motifs and the difficulties confronted while maintaining traditional cultural representation, it is hoped to seek out and think over suggestions and solutions to keeping the local power embedded in traditional crafts and their importance in our cultural form, continually maintaining these crafts as the symbol of traditional culture, and safeguarding their role in the cultural memory.

Keywords: Paiwan, glass bead, Austronesian, ornament

Non-invasive on-site analysis of enamelled pottery, glass and metal artefacts.

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For more than a decade, the strong miniaturisation of electromagnetic sources and detectors led to the availability of different portable instruments, namely Raman microspectrometer[1-3], X-ray Fluorescence handheld analyzer [4] and UV-visible spectrometer [5]. These instruments inform on the phase/structure, elemental composition and chromophores, respectively [6,7]. At the time of their production enamelled wares were advanced materials and their micro- and nano-structure carries a lot of information about their making process, important information to distinguish genuine from copy, or to trace technological exchanges [3-8]. We present a review of the state of the art of the non-invasive study of coloured artefacts and discuss representative examples of innovation or of technological transfer.

1. Ph. Colomban, V. Milande, L. Le Bihan, *On-site Raman Analysis of Iznik pottery glazes and pigments*, J. Raman Spectrosc. 35 (2004) 527-535.
2. Ph. Colomban, *The on-site/remote Raman analysis with portable instruments - A review of drawbacks and success in Cultural Heritage studies and other associated fields*, J. Raman Spectrosc. 43 [11] (2012) 1529-1535.
3. D. Mancini, C. Dupont-Logié, Ph. Colomban, *On-site identification of Sceaux porcelain and faïence using a portable Raman instrument*, Ceramics International 42[13] (2016) 14918-14927.
4. G. Simsek, Ph. Colomban, F. Casadio, L. Bellot-Gurlet, K. Faber, G. Zelleke, V. Milande, L. Tilliard, *On-site identification of early Böttger red stonewares using portable XRF/Raman instruments: 2, glaze and gilding analysis*, J. Am. Ceramic Society 98[10] (2015) 3006-3013.
5. C. Fornacelli, Ph. Colomban, I. Turbanti Memmi, *Toward a Raman/FORS discrimination between Art Nouveau and contemporary stained glasses from CdSxSe1-x nanoparticles signatures*, J. Raman Spectrosc. 46[11] 2015 1129-1139.
6. Ph. Colomban, *The destructive/non-destructive identification of enamelled pottery and glass artifacts and associated pigments –A brief overview*, Arts 2013, 2(3), 77-110 doi:10.3390/arts2030077
7. G. Simsek, Ph. Colomban, S. Wong, B. Zhao, A. Rougeulle, N.Q. Liem, *Toward a fast non-destructive identification of pottery: the sourcing of 14th-16th century Vietnamese and Chinese ceramic shards*, J. Cultural Heritage 16[2] (2015) 159-172.
8. Ph. Colomban, Y. Zhang, B. Zhao, *Non-invasive Raman analyses of Falangcai and related Qing porcelain. Searching evidence of the use of European pigment technology*, Ceramics International, 43 (2017) pp. 12079-12088

Problems with unstable glasses manufactured in Europe and Asia during the 17th to 20th centuries.

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The Corning Museum of Glass

Unstable glass compositions are known in Europe as early as the 17th century, when glass manufacturing workshops in Venice, Western Europe and England were experimenting with new glass preparations in order to achieve crystal clear glasses. These developments led to the manufacture of numerous unstable glasses that now exhibit various stages of glass “disease”, more commonly known as “crizzling” and “weeping”. Unfortunately, the Western European glass manufacturers then influenced glass production both to the East (Asia) and to the West (America), bringing recipes for similar unstable glasses.

We are now able to distinguish some of these influences, and the reasons behind them. Dr. Robert Brill, retired Research Scientist from the Corning Museum of Glass has analyzed numerous European, Asian and American glasses and has found similar compositions that indicate these glasses had excess amounts of alkali, mainly potassium and sodium carbonates, and too little stabilizer (CaO). Initially, this was undoubtedly an advantage for the glassblower, because these glasses were softer and remained more fluid at lower temperatures. The glass melts were easier to work into very complicated shapes, and produced a much more beautiful clear glass. However, over time, and exposure to fluctuating environments during use and storage, these high alkali glasses are subject to hydration, and eventual breakdown of the glass structure (crizzling).

Continuing research indicates that many more glasses are sensitive to this atmospheric deterioration, but it is difficult to always predict. Non-destructive analysis, such as X-ray Fluorescence Analysis can help identify some, but not all of the elements in a glass composition, and new advances are being made in comparing these results to earlier destructive quantitative analyses (electron microprobe or mass spectrometry), and now better compositional results using Laser Ablation (LA-ICPMS).

It is interesting to see that some of the earlier glass manufacturers realized that they were producing unstable glasses, for example in England, Ravenscroft in 1676 actually stopped production for a time to rework their glass compositions. Similarly, advances were also achieved since the founding of the first royal glasshouse within the Imperial City in Beijing in 1696.

Earlier glasses, such as Roman soda-lime-silica glasses show very little or no such problems of instability. This is partly a result of the well-balanced glass compositions, and the fact that burial creates a different protective phenomenon, that of weathering layers on the glass that are a result of centuries of alkali loss prior to excavation.

There is no complete conservation treatment to restore damaged crizzled glasses. Prolonged high humidity can cause extensive alkali hydration, with eventual dissolution of the silica matrix. Cleaning or rinsing the glass with deionized or distilled water is recommended to remove any accumulated alkali on the surface. Previous damage to these deteriorated glasses can be treated and storage in a controlled environment of 40-42 % RH, with circulating air movement, appears to slow down or almost stop any further advancement of deterioration.

Imitation and innovation: cultural influences in glassmaking in early modern Europe and China

Florian Knothe

University Museum & Art Gallery, University of Hong Kong

Early European experiments into porcelain-making were strongly related to glassmaking for the basic and long-lasting misunderstanding that Chinese hard-paste porcelain was a vitreous rather than a clay-based material. Glasshouses in Venice (c.1500), in Nevers (c.1675), in Munich (c.1680), and in Dresden (c.1700), made white glass by adding bone-ash or chalk, whereas early European ceramicists, such as those in Francesco I de Medici's (1541–1587) workshop in Florence (since 1575), and potters in Rouen and Saint Cloud (since 1673 and 1683 respectively), produced earthenware, typically coated with a tin-based glaze in order to achieve closer resemblance to Asian wares. 'True' hard-paste porcelain, however, was first fired in Europe only with Ehrenfried Walther von Tschirnhaus (1651–1708) and Johann Friedrich Böttger's (1682–1719) experiments in Dresden in 1708, and led to the establishment of the Meissen manufactory there in 1710.[\[i\]](#)

For the focus on my talk on Chinese influences over European glassmaking, Tschirnhaus' enduring research into the composition of porcelain is highly important as he ran several glasshouses, the primary of which, the Königlich-Polnische Kurfürstlich Sächsische Glasfabrique (1699–1760) not only offered him the environment to test different clays, but principally engaged in the manufacture of glass – mostly colorless, but occasionally of opaque color.[\[ii\]](#) Opaque glass had become popular in Venice during the Renaissance, when marbled and chalcedony glass imitated hardstone, and white, as well as translucent green and blue glass, served as vessels that could be richly enameled allowing the painted and occasionally gilded inscriptions and heraldry to visually separate from the colored ground. Other undecorated *lattimo* objects, however, simply presented alternatives to *crystallo* glass, and are neither enameled nor imitations of porcelain, as their forms are none present in ceramic production. [\[iii\]](#)

Altogether, in the sixteenth and seventeenth centuries, white glass represented glass rather than porcelain type objects and were made in white instead of colorless glass for their clean background for enamel colors, or the elegant aesthetics of their uniform polychrome color and shape. However, it is worth highlighting also a couple of European artifacts that differ importantly in their color scheme and lack of decoration from porcelain counterparts but that closely resemble them in shape and

fulfill the same utilitarian purposes. Objects like colorless glass covered dishes and *glacières* repeat in glass vessel types manufactured by the most celebrated porcelain factories, such as Meissen and Sèvres. They testify to an influence of porcelain over glass that had stylistic and thereby cultural dimensions as well as economic consequences. New types of table ware, such as *glaciers*, do not only illustrate the ever more intricate dining customs and newly fashionable variety of domestic objects employed in elaborate table settings, but further signalize the adoptability of one object type in media such as porcelain, glass and silver that together formed part of the display since the seventeenth century. As textural descriptions and rare depictions of buffets and dining tables illustrate, precious domestic treasures were further ennobled by pairing them with non-functional glass table ornaments, *trionfi*, silver and gold mounted hardstones and shells, and East Asian import goods.^[iv]

As the fascination with imported Chinese artefacts continued and a fashion for *chinoiserie* developed, glasshouses throughout Europe developed products that adapted shapes and iconographic features known from East Asia in order to both imitate and emulate ‘exotic’ Chinese wares. This phenomenon was neither short-lived nor was it limited to Europe, but, indeed, grew into a truly cross-cultural influence when also Chinese glassmakers imitated in glass enameled porcelain of the Qianlong period.

^[i] As Ulrich Pietsch discusses, it seems plausible that Tschirnhaus learned of the fine white clay used for the production of porcelain in China by reading Marco Polo, Gaspar da Cruz (act. in 1569), Matthäus Dresser (1536–1607), or Jan Nieuhof (1618–1672), all of whom described the addition of ‘a certain sort of soil’ to the batch formula. Tschirnhaus, however, may not have known the exact composition of this white clay, for it was his colleague Böttger who seems to have discovered the necessary kaolin, and who presented to August the Strong (1670-1733), Elector of Saxony (1694-1733) and King of Poland (1697-1706) the first successful samples of European hard-paste porcelain. See Ulrich Pietsch, ‘Tschirnhaus und das europäische Porzellan’, in Staatliche Kunstsammlungen Dresden (ed.), *Ehrenfried Walther von Tschirnhaus (1651-1708): Experimente mit dem Sonnenfeuer*, Dresden: Staatliche Kunstsammlungen Dresden, 2001, pp. 68-73.

^[ii] Gisela Haase, ‘Tschirnhaus und die sächsischen Glasshütten in Pretsch, Dresden und Glücksburg’, in Staatliche Kunstsammlungen Dresden (ed.), *Ehrenfried Walther*

von Tschirnhaus (1651-1708): *Experimente mit dem Sonnenfeuer*, Dresden: Staatliche Kunstsammlungen Dresden, 2001, pp. 61 and 63.

Haase quotes (p. 63) from a letter Tschirnhaus wrote to the philosopher and mathematician Gottfried Wilhelm Leibniz (1646-1716) on October 6, 1700, praising the successes of the newly established Dresden glasshouse and alluding to the advantages he personally saw for his porcelain research, saying that ” ... dass vornehmste ist dass [ich] nunmehr ein stettes fewer umsonst habe, da [ich] vieles propiren kan, und dass [ich] herrliche glässer werde haben können, umb die opticam ad talem perfectionem zu bringen, wie ich in Idea habe” (original correspondence in the Landesbibliothek Hannover, block 135).

[\[iii\]](#) An elegant Netherlandish goblet in the Corning Museum of Glass shows strong similarities with turned ivory pokals produced in princely workshops in Renaissance Bavaria.

[\[iv\]](#) Wolfram Koeppel (ed.), *The Art of the royal Court: Treasures in Pietre Dure from the Palaces of Europe*, exh. cat., New Haven and New York: Yale University Press, 2008, pp. 232-237, 248-249, 252-256, 271-273, and 278-279.

18-20 世紀初東西方文化交流中的玻璃藝術

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基於“歐洲藏中國清代玻璃器的調查與研究 the Investigation of the Qing Dynasty Chinese Glass in European Countries”國家級研究課題，作者以一位玻璃實踐者的身份，對海內外 20 多家博物館藏千餘件清代玻璃器進行了實物研究，在對比同時期歐洲地區的玻璃實物及文獻資料的基礎上，客觀地分析 18 至 20 世紀初東西方文化、經濟交流中玻璃製作、成型和裝飾技藝的發展及演變，揭示西方實踐對於中國清代玻璃藝術以及中國傳統工藝美術對於歐洲玻璃實踐的相互作用。

文章主要包括以下幾方面內容：

1. 西方玻璃實踐影響下的中國清代玻璃；以清代玻璃器中的圈足形式和威尼斯風格 (Façon-de-Venice) 為案例分析吹制玻璃工藝在 18 世紀 (康熙、雍正和乾隆朝時期的造辦處玻璃廠) 以及 19 世紀民間玻璃工業的發展與演變；
2. 中國傳統手工藝對於歐洲地區玻璃製作的影響：中國陶瓷造型、顏色和釉彩裝飾方面對於 18-20 世紀初威尼斯、歐洲中部 (波西米亞 Rollhütte、德國 Thuringia)、法國 Baccarat 巴卡拉玻璃、義大利 Venini 玻璃製作的影響；
3. 中國清代套料玻璃器與歐洲玻璃實踐：清代套料雕刻玻璃對於 19 世紀英國 Stourbridge 地區玻璃工業、20 世紀法國新藝術運動玻璃藝術家 Emily Gallé 等的深遠影響。

Glass making -- cultural exchange between East and West from 18th to Early 20th Century

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Based on the national research project, *The Investigation of the Qing Dynasty Chinese Glass in European Countries*, Dr. Shelly Xue, as a practitioner in glass making, after researching more than 1,000 pieces of Qing Dynasty Chinese glass collected in over 20 museums in China and European countries, will analyze the development of glass making, forming and decorative methods in the cultural and economic exchange between East and West from 18th to early 20th century by comparing with the glass pieces made in Europe at the same period and related documental materials, and seek to reveal the West influence on the Qing Dynasty Chinese glass and how the traditional Chinese arts and crafts influenced the Western practice.

Content:

1. Qing Dynasty Chinese Glass under the Influence of Western Practical Glass Making: The author will analyze the development of Chinese blown glass in 18th century (imperial glass workshops in Kangxi, Yongzheng and Qianlong reign period) and the non-official glass industry in 19th century with the case study of the ring-foot and Façon-de-Venice pieces of the Qing Dynasty.
2. The Influence of Traditional Chinese Arts and Crafts on European Glass Making: The author will reveal the influence of the form, color and glaze of Chinese porcelains on French Baccarat and Italian Venini glass making, and also the one in Venice and central Europe (Rollhütte, Bohemia and Thuringia, Germany) from 18th to early 20th century.
3. Qing Dynasty Chinese cased & cameo glass and European glass industry: The author will indicate the influence of Qing Dynasty Chinese cased & cameo glass on glass industry in Stourbridge, Britain in 19th century and Emily Gallé, the glass artist of French Art Nouveau in early 20th century.

International currents in Chinese glass - Bristol Museum & Art Gallery, UK

Kate Newnham

Visual Arts, Bristol Museum & Art Gallery, UK

Bristol Museum & Art Gallery in the west of England holds one of the most important collections of Chinese glass outside China, comprising about 300 pieces. It was bequeathed in 1950 by Mr H R Burrows Abbey through the Art Fund and supplemented since then by further acquisitions. The majority of the collection dates to the Qing dynasty (AD 1644-1911) and a substantial number of pieces are likely to have been made in the imperial workshops in Beijing.

A fascinating aspect of Chinese glass is the way in which it provides material evidence of interactions between China and other parts of the world, whether through the glass materials, techniques or styles. This paper will consider examples of these interactions through works in Bristol's collection. The earliest Chinese glass object at Bristol, an eye bead dating to the 4th-3rd centuries BC, shows the stylistic influence of eye beads from the Eastern Mediterranean as well as an early use of cobalt, a pigment likely to have been imported. There are a few examples of early blown glass in the collection dating to the Period of Disunity (AD 221-589) or the Sui dynasty (AD 589-618) which point to technical influences from abroad, associated with the spread of Buddhism. In addition Bristol holds a wheel-cut Iranian vase (AD 800-900) said to have been unearthed near Xi'an, an example of foreign glass as a luxury imported good.

A group of 'crizzled' (degraded) glass from the Kangxi period (AD 1662-1722) shows the likely results of experimentations in glass-making at the imperial glass workshop in Beijing, established by the Bavarian Jesuit priest, Kilian Stumpf in 1696. Further European influences in Chinese glass can be seen in Bristol's collection in the use of diamond-point engraving, Venetian-style cane-work techniques and aventurine ('golden star') glass. It is possible that some Chinese glass of a clear ruby colour was made using colloidal gold, a European technique but this requires further analysis.

Glass snuff bottles, albeit with Chinese designs, reflect the need for containers for imported powdered tobacco whilst opaque white glass reveals interactions between Europe and China as well as a strong impetus to create a jade-like material. Other cultural interactions may be evidenced in glass made in the imperial workshops in the eighteenth century as diplomatic gifts or as utensils for use in Lamaist Buddhist practices as well as commercial glass made in subsequent centuries for foreign

markets.

Chinese glass is known particularly for the carved overlay technique where the craftsman carves through from one layer of glass to another and the presentation will touch upon the extent to which this incorporates stylistic or technical influences from abroad. The technique is first known in Roman examples such as the Portland Vase (AD 1 – 25) now in the British Museum, and was itself influenced by ancient traditions of gemstone carving.

Contemporary Chinese glass continues to reflect international influences and this will be considered in works by glass artists such as Dr Guan Donghai and Dr Shelly Xue.

多面體造型及相關問題一 以乾隆朝玻璃胎畫琺瑯黃地福壽八楞瓶為例

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多面體是指由平面和直線組成的幾何式形體而言。因造型特殊，無論是否出於模製，接合面都需要仔細計算方能成器，故鮮見於工藝美術之列。然而，清乾隆朝的玻璃器中極其難得的存在一件「玻璃胎畫琺瑯黃地福壽八楞瓶」（以下簡稱乾隆八楞瓶）。該器長頸之下的器身由八個正三角形和六個正方形共同組成一個十四面體。追溯文獻記載，無論是乾隆六年（1741）《內務府造辦處各作成做活計清檔》（以下簡稱《活計檔》）、道光十五年（1835）乾清宮《琺瑯玻璃宜興磁胎陳設檔案》（以下簡稱乾清宮《陳設檔》），及1920年代彙編的《故宮物品點查報告》（以下簡稱《點查報告》）均將之登錄為「八楞」瓶，其名稱和今日理解之多面體似有落差。另一方面，乾隆八楞瓶圈足「乾隆年製」款識，則說明該品出產自十八世紀的宮廷作坊。據此對比其他類型工藝品，而可發現整體形制近似於英國維多利亞與亞伯特博物館（Victoria and Albert Museum）藏鑄造於伊朗呼羅珊省（Khorasan）的青銅器多面體玫瑰水瓶。由於青銅多面體玫瑰水瓶定年為十至十二世紀（以下簡稱十至十二世紀青銅瓶），離乾隆朝已有一段時間。在此之下，究竟是什樣的機緣而讓八楞瓶再度出現？與傳教士游走清宮引進西方文化有關，還是來自於過去未曾注意到的伊斯蘭風潮再度興起的影響？本文以下擬以乾隆八楞瓶做為討論的基點，一方面檢視學界已然存在的論點，另一方面亦透過實際作品例探討乾隆朝多面體器形出現的契機。

Polyhedron design and its formation: glass octagonal vase during Qianlong reign (1736-1795) in the Qing dynasty

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Polyhedron is a solid geometric figure formed by planes and lines. It is rarely seen in artifacts because its connecting surfaces require thorough calculation. Among the glass objects in the imperial collection of Qianlong emperor, “Glass octagonal vase with inscription of blessing and longevity in painted enamels” (fig.1) is a tetradecahedron formed by eight triangular and six square surfaces, also known as an Archimedean solid. However, according to the “Imperial Household Department Archives” (1741), “Archive of Cloisonné, Glass, Enamels, and Yixing ware” (1835), and “Object reports of the National Palace Museum” (1920), this vase is categorized as an “octagonal” vase but this categorization fails to describe the true nature of its shape. This glass vase is made by the Qing court and has a reign mark of the Qianlong emperor at its bottom, proving its origin from the imperial workshop of the eighteenth century. Compared to other objects in history, this vase is similar to the bronze “Rosewater Sprinkler” made in the Khorasan province in Iran around the tenth to twelfth centuries, now a collection of the Victoria and Albert Museum. How did Qianlong emperor’s glass octagonal vase emerge after such a long time? Was it introduced by Western missionaries to the Qing court? Or was it a transformation based on the faceted vase from the Ming dynasty? This article aims to discuss the preceding polyhedron designs before the Qianlong period and the meaning and emergence of polyhedron designs during the Qianlong period.

清代宮廷珍玩多寶格中的玻璃文物

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玻璃的製作與使用在華夏文化中有著源遠流長的發展歷程。自先秦時期以降持續進展，既反映域外文化的影響，亦展現風貌獨特的發展形態，於十八世紀的清代中期達於高峰。在清代皇室的重視與探求之下，玻璃器用不僅為宮廷生活提供多面向的實用功能，也被納入品賞收藏的範疇。國立故宮博物院典藏之清宮舊藏玻璃文物，有相當數量原收貯於宮中百什件、多寶格珍玩匣盒。此類器物來源不一，功能多元。本文將嘗試結合相關文物與文獻檔案，探討其中的收藏脈絡與文化現象

Glass artifacts in the curio box collections of the Qing court

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The development of glass manufacturing techniques and the application of glass materials for various usages demonstrated unique features since the Pre-Qin era of Chinese history. Integration of foreign influence reached a high point during the 17th and 18th centuries with the establishment of the Imperial Glass Workshop under the supervision and support of the Qing Dynasty Court. Among the objects stored in the curio box collections of the National Palace Museum, there are glassworks regarded as treasure items, testifying the diverse range of glass artifacts made for or presented to the imperial court via different channels. This paper attempts to verify certain types of glass artifacts preserved in the curio boxes and their likely context through correlative research of extant objects and Qing dynasty archival sources.

東西方歷史中的金星玻璃：起源、製造與藝術性

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金星玻璃(aventurine glass)據傳大約在十七世紀上半葉由威尼斯慕拉諾的玻璃工人無意間製造出來，主要的特徵是在不透明的紅棕色玻璃中分佈著無數金黃色澤的金屬顆粒。與灑金玻璃(gold-flecked glass)在玻璃製造過程中灑入金粉之作法不同，金星玻璃中肉眼可見的金屬顆粒是在緩慢冷卻過程中，於一還原氣氛下所形成的銅晶體顆粒。由於生產過程中必須掌握的變數甚多，不易成功，需要機運，因此就像奇遇(aventure)一樣，此亦是其名稱由來之故。也因為金星玻璃不易製造成功，因此並未成為十七世紀以後西方玻璃發展史上的主要類型之一，但在一些歷史文獻中，我們仍可發現使用金星玻璃所作成的器物之記載。

在另一方面，從清宮檔案及西方傳教士書信與紀錄中，也可知中國在康熙時期(1662-1722)便有包含金星玻璃在內的許多西方玻璃傳入，並且受到皇帝的喜愛。康熙三十五年(1696)，更在皇帝的意旨下，於蠶池口的法國傳教士天主堂旁成立了玻璃廠，由紀里安神父(Kilian Stumpf, 1655-1720)負責管理。根據德里格(Teodorico Pedrini, 1671-1746)的記載及其他傳教士的書信，康熙時期清宮裡便已開始試驗製造金星玻璃。不過由於至今並無確認無疑的康熙朝所留傳下來的金星玻璃，也沒有相關的技術和配方紀錄，因此，甚難知曉康熙朝清宮裡所製造的金星玻璃模樣。現今所看到的清代金星玻璃，主要製造於乾隆時期(1736-1795)。從湯執中((Pierre d'Incarville, 1706-1757)的記載中，我們知道在1741年金星玻璃燒製成功之前，御用玻璃廠也努力嘗試了許多方式試圖製造這種帶有金色星點光澤的紅棕色玻璃，但由於少了一些關鍵的因素，一直沒有成功。至於最後燒製成功的關鍵，也因為文獻無確切記載，我們並無法掌握其燒造技術層面的細節。不過可以確認的是，在湯執中和紀文(Gabriel-Leonard de Brossard, S. J., 1703-1758)擔任玻璃廠的技術專家期間，是乾隆朝玻璃製造的高峰期(1740-1759)，這些金星玻璃塊料被製造出來後，再依清宮既有的藝術形制和品味，進行冷加工的雕刻處理，成為許多類似玉雕造型的新藝術品項。

本論文主要有兩個目的，一是基於前人相關的研究基礎上，重新梳理東西方相關文獻，探討在東西方不同時空背景中金星玻璃起源背後的文化、藝術與技術因素，同時也將結合實際對幾件清代金星玻璃的科學分析，進一步探究其配方與燒造技術。另一方面，作為一種新型式的藝術品項，其在東西方玻璃藝術的發展過程中，所扮演的角色並不相同，我們也將從材料、技術與東西方審美的角度，討論這些差異。

Aventurine glass in Western and Eastern History: occurrence, fabrication and artistry

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It is reported that aventurine glass was accidentally invented by glass artisans of Murano in Venice in the first half of the seventeenth century. Presenting numerous golden metal particles, which are actually minute copper crystals, within its mass, it is produced with a slow cooling process in a reducing atmosphere after firing at a higher temperature. Unlike gold-flecked glass in which the gold powder is added into molten glass for forming the glass speckled with gold, the copper crystals of aventurine grow gradually inside the glass during cooling procedure. As it was not easy to successfully make aventurine glass, it received its name “aventurine” implying that it was made by chance rather than science. Besides, probably because of its rarity, aventurine never became the major glass works in Western history, though some small articles can still be found in different museums.

On the other hand, on the basis of the ancient Chinese documents and a series of letters and notes written by the Jesuit missionaries employed by the Qing court, aventurine and other glass objects have been imported from Europe to China in the reign of Kangxi (1662-1722) and highly appreciated by the emperor. In 1696, under the direction of Kilian Stumpf, SJ (1655-1720), the imperial glass workshop was established in the French Jesuit complex known as the Beitang. According to Teodorico Pedrini (1671-1746), aventurine glass was fabricated domestically in Kangxi’s reign. However, due to lack of ascertained aventurine objects of this period, it is hard to know their exact type and modeling. The aventurine articles passed down from the Qing dynasty were principally produced during the Qianlong era (1736-1795). Two Jesuit missionaries, Gabriel-Leonard de Brossard (1703-1758) and Pierre d’Incarville (1706-1757), were formally employed by the Qing court to take part in imperial glassmaking in this period. The letters of d’Incarville reveal that many efforts have been made to produce aventurine glass before obtaining successful block in 1741. Nevertheless, the technical details and key factors of making such a rare type of glass at the Qing court are still unclear and require further study. It is worth noting that once an aventurine block was produced, it was then carved and treated with cold process like jade and became a new type of artifact in the Qing dynasty.

This study will focus on some points: discussing the cultural and technical factors of the occurrence and development of aventurine glass both in Western and Eastern history basing on literature review and previous study; investigating the

materials and firing techniques for producing aventurine glass by analyzing some articles housed in NPM with different analytical methods; exploring the artistry of this new type of aventurine artifacts both in Western and Eastern cultures from the points of view of technique and aesthetics .

國立臺灣博物館鑲嵌玻璃的材質檢測

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國立臺灣博物館(簡稱臺博館)創於西元1908年的日治時期，是臺灣最早創立的公立博物館，其前身為「臺灣總督府民政部殖產局附屬博物館」，主體建築物於1915年落成。此座建築具仿中古歐式的希臘式立柱式外觀，大廳中央圓頂則為鑲嵌彩色玻璃天窗。超過百年歷史的臺博館建築，至今曾經歷過數次的修繕，分別是西元1961年、1994年及2004年間的三次大修和數次小修；但大廳圓頂的鑲嵌彩色玻璃構件，則在2004年全面性進行修繕和復舊工作。

本研究材料為2004年修繕所換補的鑲嵌彩色玻璃樣本，使用X光螢光分析儀檢測玻璃的組成化學成分，用以討論鑲嵌玻璃所含元素種類與其繽紛色彩的關係，以為未來研究、保存及維護臺灣鑲嵌彩色玻璃的參考。

檢測結果顯示，臺博館的鑲嵌彩色玻璃屬於鈉鈣矽酸鹽玻璃，主要由SiO₂、Na₂O、CaO等三種氧化物組成。不同顏色玻璃亦檢測出不等量的F、Mg、Al、Cl、K、Zn、Mn、Ba、As、Cu、Cr、Ti、Cd等元素，可能為原料中之雜質或製造過程中的添加物。其中Cu、Cr、Ti、Cd、Mn可能是使臺博館鑲嵌玻璃產生不同色彩的主要化學成分。

本研究亦將鑲嵌玻璃進行可見光光譜及拉曼光譜量測，及探討其與化學成分之關係。

Material identification of stained glass in National Taiwan Museum

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The oldest national museum in Taiwan, the National Taiwan Museum (NTM) was first founded in 1908 during the period of Japanese colonization as the “Bureau of Productive Industries’ Affiliated Museum under the Government-General of Taiwan”. The construction of the current main building was completed back in 1915. In addition to its much-admired Greek-style façade supported by regal Corinthian columns, the NTM building houses in the center of its lobby a colorful stained glass domed rotunda that has won kudos from visitors. Established for nearly one century, the NTM building has undergone three major renovations (1961, 1994, and 2004) and several minor ones. Its alluring stained glass ceiling, however, did not go through any comprehensive repair or restoration until 2004.

After securing fragments of the replacing and replaced stained glass during the 2004 restoration, we examined the chemical compositions of the glass materials with X-ray fluorescence. By identifying the types and amounts of the various elements in the stained glass and studying the chemical compositions of the glass fragments, we will discuss the possible relation between the chemical compositions of the glass and its fascinating colors. The results will hopefully serve as a useful reference for future research, preservation, and maintenance of stained glass artifacts in Taiwan.

Results of examination indicate that the NTM stained glass is mainly composed of SiO₂, Na₂O, and CaO, all oxidants commonly found in sodium-calcium silicate glass. Found in the glass fragments of different colors are various amounts of F, Mg, Al, Cl, K, Zn, Mn, Ba, As, Cu, Cr, Ti, and Cd, which may have come from impurities in the starting materials or additives used during the glass manufacturing process. Among those elements, Cu, Cr, Ti, Cd, and Mn are identified to be possible elements contributing to the generation of different colors in the NTM stained glass.

The visible light spectrum and Raman spectrum of the stained glass have both been acquired. We will discuss the result and its relation with the glass chemical composition.