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Variations in Hiroshige's Print "The Plum Garden at Kameido"

Capucine Korenberg

Department of Scientific Research, The British Museum, Great Russell Street, London WC1B 3DG, UK; ckorenberg@britishmuseum.org

Abstract: This work examines variations in Utagawa Hiroshige's "The Plum Garden at Kameido" by studying 82 surviving impressions of the print. Through comparative analysis, differences were observed across printings, driven by changes in woodblocks, block wear, colourants and printing techniques. Four distinct printing 'states' were identified, reflecting evolving production methods and adaptations to meet commercial demands, but also woodblock wear. Early impressions preserve Hiroshige's artistic intent more faithfully, featuring intricate printing effects, a greater number of printing steps and minimal block wear. Later states demonstrate alterations to colour schemes, reduced printing complexity, printing misalignment and woodblock anomalies, highlighting the pressures of mass production and publisher-driven decisions. Evidence of fading was observed in several impressions, indicating the original colours would have been more vibrant. This research underscores the importance of detailed analysis in understanding the material and artistic evolution of Japanese *ukiyo-e* prints. It offers new insights into the publication chronology of "The Plum Garden at Kameido" and calls for further studies to explore the technological, artistic and commercial factors shaping *ukiyo-e* printmaking. Few in-depth investigations exist that have explored the evolution of specific designs over time.

Keywords: Japanese woodblock print; publication chronology; *ukiyo-e*; woodblock wear; Hiroshige

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1. Introduction

"The Plum Garden at Kameido" (*Kameido Umeyashiki*) (Figure 1) is one of the most celebrated *ukiyo-e* woodblock prints by the Japanese artist Utagawa Hiroshige (1797–1858). It was published at the end of 1857 as part of the series "One Hundred Famous Views of Edo" (1856-8), comprising 118 prints by Hiroshige, one by his successor, Hiroshige II, and a table of contents. Umeyashiki is the name of a plum garden in the Kameido district east of the Sumida River in Tokyo. It disappeared in 1910, destroyed by flooding. Hiroshige's print depicts the garden seen through the tree branches of a plum tree in the foreground. In early spring, the blossoming plum trees of Umeyashiki attracted many visitors and twelve are visible near a teahouse in the background. The perspective in this print differs significantly from earlier works by Hiroshige, which depict visitors to Umeyashiki in the foreground (Figure 2). Hiroshige's print is notable for having been reproduced by the Dutch artist Vincent van Gogh in his oil painting "Flowering Plum Orchard (after Hiroshige)" of 1887.

Like other Japanese prints at the time, "The Plum Garden at Kameido" was mass-produced using a set of cut woodblocks, one block for the outlines, the *omohan* or key block, and several woodblocks for the coloured areas. The production of prints was a commercial enterprise, and a design was printed as long as there were customers willing to buy the print. Generally, the key block was cut in hard mountain cherry wood with the colour woodblocks cut in softer wood, which was more susceptible to wear down and may have

required replacing. Therefore, various printings of a given design would be produced using the same key block, but not necessarily the same colour woodblocks. In addition, some of the original colour blocks were sometimes omitted from the printing. Some experts estimate that Hiroshige's best-selling designs may have been printed up to 15,000 times [1]. Japanese prints were inexpensive in the Edo period (1615–1868): for instance, one could buy a print for the same price as approximately two helpings of noodles in the 1830s [2].

(**a**) (**b**) (**c**)

Figure 1. Three impressions of "The Plum Garden at Kameido" by Utagawa Hiroshige, 1857. (**a**) First state, The British Museum, accession number: 1954,1113,0.29 (donated by Mrs Mabel B. Hopper); (**b**) second state, The British Museum, accession number: 1948,0410,0.65 (donated by Henry Bergen); (**c**) fourth state, The British Museum, accession number: 1915,0823,0.692. All images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Figure 2. "The Plum Garden at Kameido" by Utagawa Hiroshige, 1853. The British Museum, accession number: 1915,0823,0.398.12. © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Not all impressions (the term 'impression' here refers to one of a number of printings made using the same key block) of "The Plum Garden at Kameido" were printed using

the same colour scheme and printing effects, as evidenced by the three impressions shown in Figure 1. Scholars and Japanese art collectors use the term 'state' to describe variations within a single edition, often evident in differing levels of key block wear or modifications to the colour blocks, such as the addition, omission or replacement of a block. 'Edition', on the other hand, refers to a distinct version of a print, usually marked by publisher-driven changes like a revised colour scheme or altered printing effects. Assessing whether an impression is from an early or late state is not straightforward. Just like European prints made before the 20th century, Japanese prints were not numbered or dated, and a different approach is required to establish where an impression falls in the history of the design. Because of the high number of impressions pulled, the woodblocks would eventually become damaged or replaced. Comparing impressions of a specific print and looking for signs of woodblock wear or differences in the colour woodblock makes it possible to distinguish between impressions from early and late editions.

In the Edo Period, as annotated proof prints specifying colours suggest (see for instance the annotated proof print for "Rooster, Hen and Chicken with Spiderwort" by Hokusai in the collection of the Victoria & Albert Museum, London, accession number: E.1361-1916, photograph available online), early printings of a Japanese print are likely closer to the artist's vision than later ones. Therefore, to understand Hiroshige's artistic aims, it is essential to identify early impressions of the first state and their original colours. Recognising the different states of a print also deepens our appreciation of the way cultural and commercial practices have evolved over time.

The aim of this research was to establish the relative publishing chronology of "The Plum Garden at Kameido", from its earliest surviving edition to its last, based on woodblock wear or replacement, colour schemes and printing effects. It should be noted that this type of research represents a recent area of scholarship, driven by a renewed focus on the materiality of prints. Only a small number of prints have been studied this way [3–5]. First, as many original impressions of "The Plum Garden at Kameido" as possible were located and digital photographs obtained. While thousands of impressions of "The Plum Garden at Kameido" were originally printed, Japanese prints were ephemera and only a small proportion have survived. Based on the photographs collected, the variations between impressions were studied to define a relative chronological sequence of states of the print. To characterise the variations in the colour schemes of "The Plum Garden at Kameido", the colourants on the three impressions in the collection of the British Museum shown in Figure 1 were analysed. Japanese woodblock prints from the Edo period were printed using a limited and well-documented range of colourants [6–9] and previous research has shown that non-invasive techniques such as X-ray fluorescence (XRF), fibre optic reflectance spectroscopy (FORS) and Raman spectroscopy are well suited for their identification [10–13]. The impressions were also examined using optical microscopy and ultraviolet light. The methods employed and results obtained are discussed below.

2. Materials and Methods

2.1. Photographs of "The Plum Garden at Kameido"

The *Ukiyo-e* Search web engine [14], which lists impressions of Japanese impressions from various national institutions, was used to locate impressions of "The Plum Garden at Kameido". Photographs of additional impressions were also obtained from the Google Arts & Culture online platform, the websites of the auction houses such as Sotheby's and Christie's, books and art dealers. In total, photographs of 82 impressions were collected (Table 1).

Table 1. List of the 82 impressions collected (with accession number if available).

Location	Institution
France (1)	Bibliothèque Nationale de France, Paris (FRBNF43789439)
Germany (3)	Museum für Kunst und Gewerbe, Hamburg (IE1897.1) Museum für Ostasiatische Kunst, Cologne (R54,14(58)) Staatlichen Kunstsammlungen Dresden
Ireland (1)	Chester Beatty Library, Dublin (J 2693)
Israel (1)	Tikotin Museum, Haifa (P-U1029)
Italy (2)	Museo d'Arte Orientale Edoardo Chiossone, Genoa Museo d'Arte Orientale, Venice (2700_12475-83)
Japan (12)	Edo-Tokyo Museum Isago no Sato Museum, Kawasaki Mogi-Honke Museum of Art, Chiba Nara Prefecture Museum National Diet Library, Tokyo (10.11501/1312266) Ota Memorial Museum of Art, Tokyo Shimane Art Museum, Matsue Shizuoka City Museum of Art Tokyo Fuji Art Museum (1171) Tokyo National Museum (2 impressions) Tsubouchi Memorial Theatre Museum of Waseda University (201-1377)
Netherlands (2)	Rijksmuseum, Amsterdam (RP-P-1956-743) Van Gogh Museum, Amsterdam (n0077V1962-800)
Poland (2)	National Museum, Krakow National Museum, Warsaw
UK (4)	British Museum, London (1954,1113,0.29, 1948,0410,0.65 and 1915,0823,0.692) Fitzwilliam Museum, Cambridge (P.3562-R)
US (21)	Allen Memorial Art Museum, Oberlin (1950.1396) Art Institute of Chicago (1925.3752, 1939.1405 and 1965.1027) Brooklyn Museum, New York (30.1478.30_PS1) Cantor Arts Center, Stanford (1984.473) Chazen University of Wisconsin, Madison (1980.1608) Clark Art Institute, Williamstown (2014.16.13) Fine Arts Museum San Francisco (54755.752) Honolulu Museum of Art (24103, 11490, 22721 and 24104) Museum of Fine Arts, Boston (06.635, 11.2223, 11.20206, 11.35818, 11.45649 and 21.10421) Seattle Art Museum (2017.23.22) Worcester Art Museum (1901.59.1244)
Auction houses and galleries (29)	Christie's, several locations (13 impressions) Egenolf Gallery Japanese Prints, Los Angeles Hartman Galleries, New York Heritage Auctions, London Hotel Drouot, Paris Japanese Prints, London Reeman Dansie, Colchester Ronin Gallery, New York (4 impressions) Sotheby's, several locations (5 impressions) Yamada Shoten, Tokyo
Others (4)	Private collection (2 impressions) Book "Japanese Prints & Drawings from the Vever Collection" by Jack Hillier, 1976, Sotheby's Publications: New York Book "Hiroshige" by Walter Exner, 1960, Methuen: London

The 82 prints exhibited variations in colour, particularly in the sky and the clothing of the background figures. These modifications in the design would have most likely been driven by the publisher. To establish the publishing chronology, both the outlines of the

impressions and the shapes of coloured areas and printing effects (e.g., gradation or solid colours) were visually compared. This method has been explained in detail elsewhere [15].

2.2. Analytical Techniques

The colourants of the three impressions of "The Plum Garden at Kameido" in the collection of the British Museum (identified hereafter as BM 1915, BM 1948 and BM 1954 for the sake of brevity) were analysed using various analytical techniques as follows.

2.2.1. Digital Microscopy

A VHX-5000 digital microscope (Keyence, Uxbridge, UK) was used to record magnified images (20–200×). The microscope is equipped with a lens VH-Z 20R, an automated stage VHX-S 550E and LED reflected illumination.

2.2.2. FORS

Fibre optic reflectance spectra on the impressions were recorded with an AvaSpec-ULS2048XL-USB2 spectrophotometer (Avantes, Apeldoorn, The Netherlands) equipped with an AvaLight-HAL-S-IND tungsten halogen light source. The detector and light source were connected with a fibre optic bundle to an FCR-7UV200-2-1.5 × 100 probe. In this configuration, light was sent and retrieved by the bundle set at approximately 45° from the surface normal, thus excluding specular reflectance. The spectral range of the detector was 200–1160 nm; nevertheless, due to poor blank correction on both the extremes of the range, only the range between 400 and 900 nm was considered. The diameter of the investigated area on the sample was approximately 2 mm, obtained by setting the distance between probe and sample at approximately 5 mm. The integration time was 100 ms and each spectrum was the average of five acquisitions. The whole system was managed by the software AvaSoft 8 for Windows™. The spectra were referenced against the area of the paper left white, i.e., with no ink applied, and corresponding to the plum blossoms on each impression.

2.2.3. Raman Spectroscopy

Raman spectroscopy was carried out with a LabRAM HR Evolution Raman confocal microscope (Horiba, Kyoto, Japan), which has 300, 600, 1200, and 1800 g/mm gratings and is equipped with four wavelengths of excitation lasers (405 nm, 532 nm, 633 nm, 785 nm). Raman spectra were recorded by focusing the 532 nm or 785 nm laser (with maximum powers of 2.4 and 4 mW at the sample, respectively) through 50× and 100× Olympus objectives with an acquisition time between 10 and 20 s for each spot collecting 5 to 20 accumulations. The materials were identified by comparison with an in-house database.

2.2.4. XRF

The impressions were analysed using an Artax XRF spectrometer (Bruker, Billerica, MA, USA) operating at 50 kV and 500 μA with a collimated beam of 0.65 mm and a counting time of 200 s. The contribution of the paper and board behind the impressions were measured in the blank areas (i.e., those corresponding to the petals of the plum blossoms) and subtracted using the proprietary Artax v5.1 software.

3. Results and Discussion

3.1. Colourants

Japanese printers during the Edo period used a well-documented but limited range of colourants, as outlined in Table 2. Green hues were typically produced by mixing blue and yellow colourants, with Prussian blue and arsenic sulphide becoming common from the 1830s [6]. Prussian blue, a synthetic pigment first manufactured in Europe in

1709, was introduced to Japan on a commercial scale just over a century later. Similarly, purple hues were achieved by combining red and blue colourants, most often dayflower blue and safflower [16,17]. These traditional dyes were derived from the petals of the respective flowers.

Table 2. Colourants used for the production of woodblock prints in the late Edo period in Japan [6–9]. Other colours (e.g., green and purple) were obtained by mixing. When there are several alternative names for a colourant, the Japanese name given here is the one listed in [7].

Colour	Colourants
Blue	*Ai* (indigo), *bero-ai* (Prussian blue), *aobana* (dayflower)
Yellow	*Kihada* (armur cork tree), *sekiō* (orpiment), *ōdo* (earth pigment), *tōō* (gamboge), *ukon* (turmeric), *zumi* (briar or crabapple)
Red	*Bengara* (earth pigment), *beni* (safflower), *shōenji* (lac), *shu* (vermillion), *suō* (sappanwood), *tan* (red lead)
Black	*Sumi* (plant soot)
White	*Enpaku* (white lead), *gofun* (shell white)

The three impressions of "The Plum Garden at Kameido" were examined using a digital microscope. In the deep red cartouches and the red sky, the paper fibres appeared to be dyed with a pink dye, accompanied by small dark red particles (Figure 3). This observation indicates a combination of a plant dye and mineral pigment. Yellow particles were detected in all the green areas, along with very fine blue particles. Differences were noted in the yellow areas of the impressions: yellow particles were present in BM 1948 and BM 1954, whereas in BM 1915 a yellow dye appears to be present.

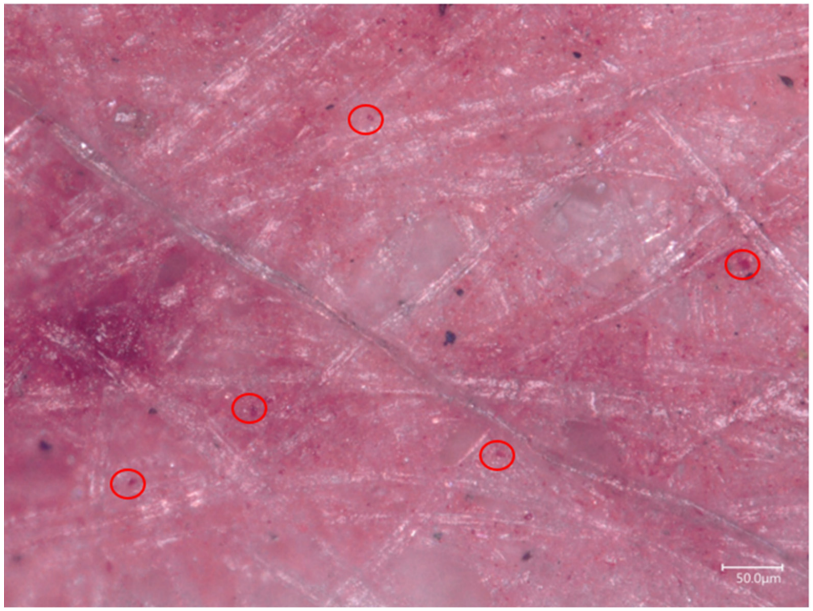


Figure 3. Photomicrograph of the peach background on BM 1954, showing the presence of small dark red particles among the dyed paper fibres, indicated with red circles. © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Prussian blue was identified in all the blue and green areas on the three impressions: XRF showed the presence of iron, and their Raman spectra had a peak at 2156 cm^{-1}, characteristic of Prussian blue [18]. The red cartouches contained mercury, and their Raman spectra corresponded to vermillion. Pink fluorescence was observed under UV light, suggesting the presence of safflower [19].

In the green areas of the three impressions and the yellow areas of BM 1948 and BM 1954, arsenic and sulphur were detected using XRF, suggesting the presence of arsenic sulphide. When examined using digital microscopy, these areas were all seen to contain yellow particles. These particles were then analysed using Raman spectroscopy to determine their molecular structure. As shown in Figure 4, there was some variation in the Raman spectra obtained, but for all the yellow particles there was a main broad band centred around 335 cm^{-1}. The broad band centred around 335 cm^{-1} is a clear indicator of synthetic amorphous arsenic sulphide (g-As_2S_3) [20], rather than the naturally occurring mineral orpiment (α-As_2S_3).

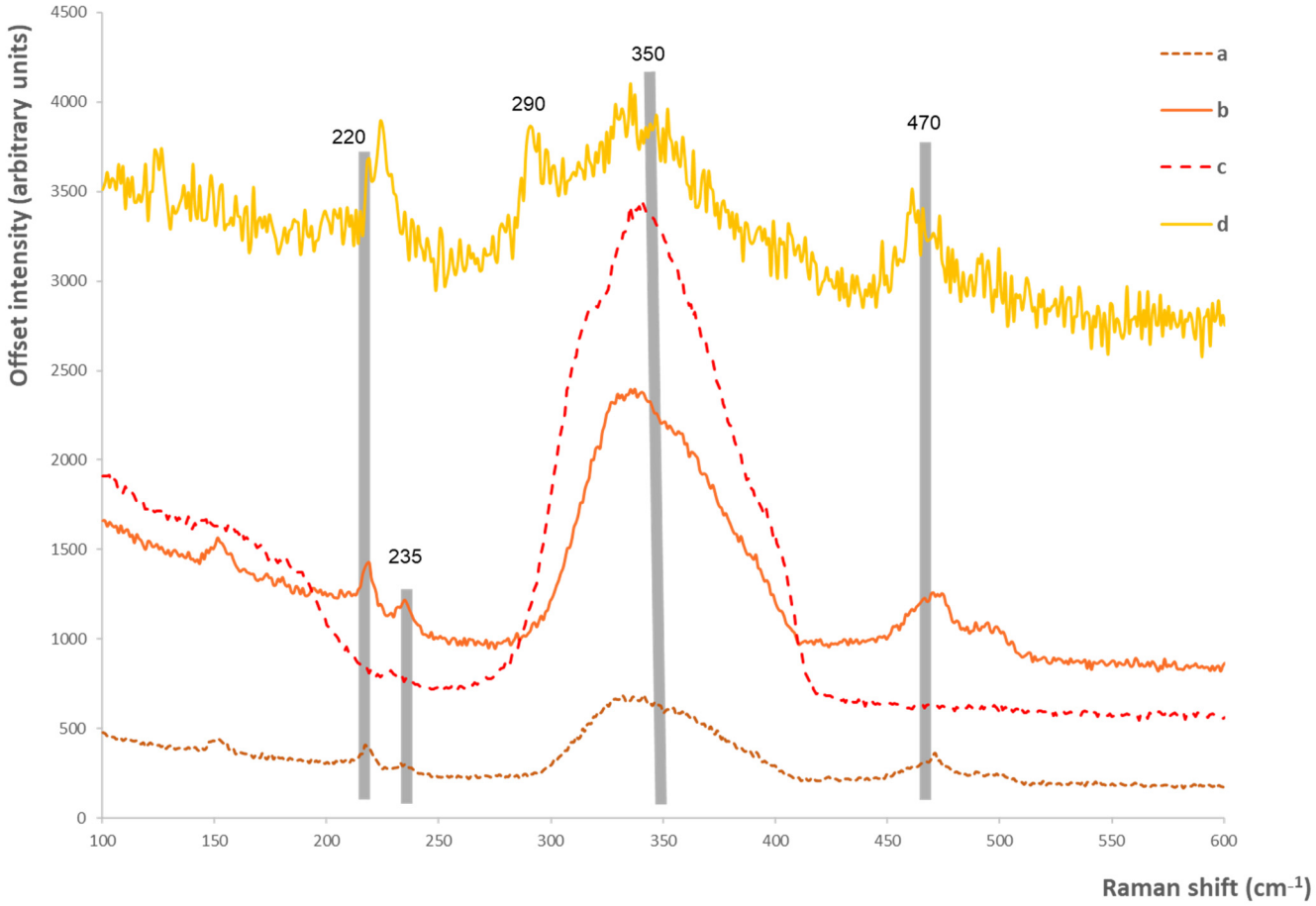


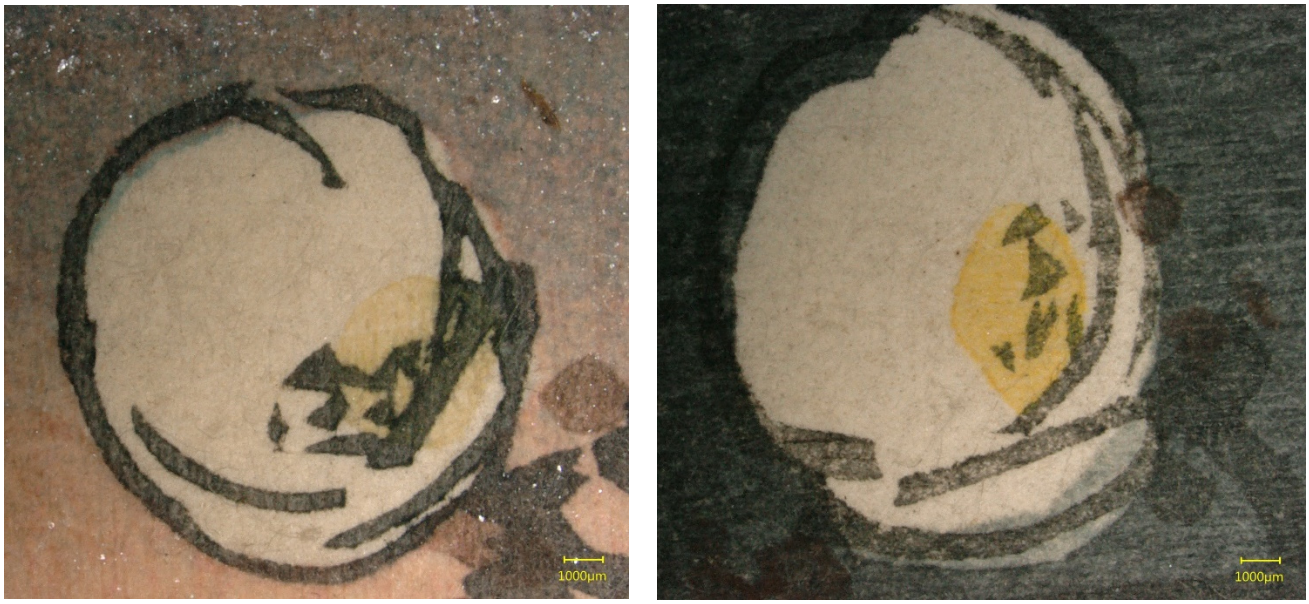
Figure 4. Selected normalized Raman spectra obtained for the yellow particles in the following areas: (a) green areas in BM 1948, (b,c) yellow areas in BM 1948 and (d) yellow areas in BM 1954.

The yellow particles in the three impressions had Raman spectra like those shown in Figure 4a–c. However, for BM 1954, some particles had a spectrum with a distinctive peak at c. 290 cm^{-1} like that shown in Figure 4d. This peak, along with other subtle variations in the spectra, suggests differences in the internal structure of the arsenic sulphide. Amorphous arsenic sulphide is phase separated in small realgar-like nanophases (β-As_4S_4) and large sulphur-rich orpiment-like clusters [21]. Like other authors [22], bands characteristic of realgar-like nanophases were observed at approximately 220, 235, 360 and 470 cm^{-1} (Figure 4). The presence of these nanophases is indicative of a dry-process synthetic method, in which dry products (e.g., arsenic oxide and sulphur) are mixed, heated and quenched. According to one study [21], the more prominent the shoulder to the main band at c. 360 cm^{-1}, the higher the temperature used in the melt-quenching process. The prominent peak at c. 290 cm^{-1} in Figure 4d can be attributed to arsenic–sulphur stretching vibration. There is a shoulder at this wavelength for some yellow particles in BM 1948

too (Figure 4c). The differences in the Raman spectra obtained for the various yellow particles point to differences in the glass structure, probably stemming from differences in production methods, such as the temperature or duration of heating.

No elements detected via XRF analysis in the yellow areas on BM 1915. However, intense yellow fluorescence was observed under UV light, indicating the likely presence of amur-cork bark or turmeric dye—the only plant-based dyes listed in Table 2 known to luminesce. According to the Ukiyo-e Print Colorant Database [23] compiled by the Museum of Fine Arts, Boston, which includes analyses of over 100 Japanese prints from the 1700s to the 1850s, turmeric was considerably more commonly used than amur-cork bark.

In the background in BM 1948, small shiny particles were visible (Figure 5a), especially at the top of the impression. These looked like flakes under the microscope and were identified as mica using Raman spectroscopy (peaks at 272 and 527 cm^{-1}). Mica is a shiny silicate mineral with a layered structure and its use in Japanese prints to add shimmer is well documented [9]. Unfortunately, the shimmering effect is not visible in photographs, making it impossible to determine whether other impressions contained mica. A summary of the colourants detected on the three impressions is given in Table 3.



(**a**) (**b**)

Figure 5. The yellow colour in the hearts of the flowers appears: (**a**) faded in BM 1948, but (**b**) vibrant in BM 1954. Also note the small shiny mica particles in the background in BM 1948 in (**a**). Both images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Table 3. Colourants detected on the three impressions.

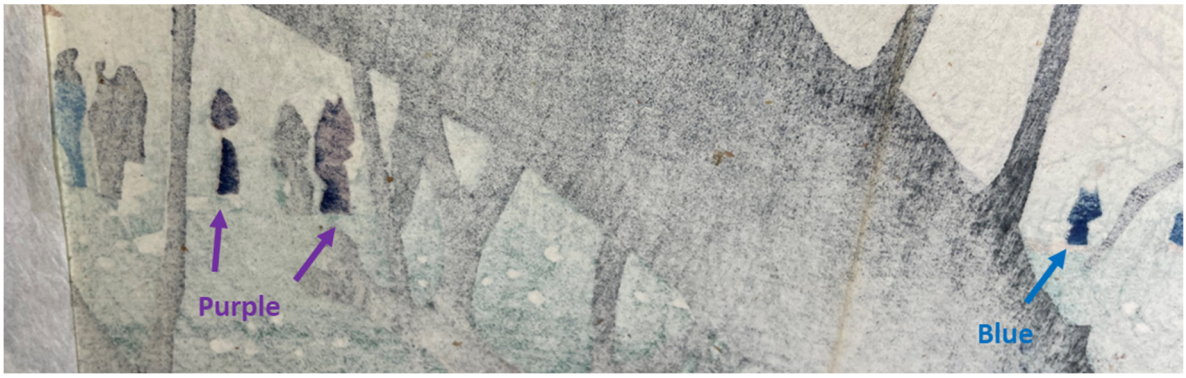
Colour	BM 1954	BM 1948	BM 1915
Blue	Prussian blue	Prussian blue	Prussian blue
Green	Prussian blue and arsenic sulphide	Prussian blue and arsenic sulphide	Prussian blue and arsenic sulphide
Yellow	Arsenic sulphide	Arsenic sulphide	Turmeric *
Red	Safflower * and vermillion	Safflower * and vermillion	Safflower * and vermillion
Purple	Prussian blue and safflower *	Dayflower * and safflower *	Prussian blue, vermillion and safflower *

* Tentative identification.

3.2. Fading

Study of the verso of BM 1948 and 1954, revealed that some colours had bled through to the back of the sheet, likely due to the pressure of the printer's pad. The verso of BM 1915 could not be assessed as it was mounted on a board support. Notably, in BM 1954, the kimonos of two people that were blue on the recto were observed as purple on the verso (Figure 6). Orange luminescence was detected in these areas on the verso but not on the recto. Plant dyes that are luminescent typically lose their luminescence as they fade [24]. This suggests that the purple colouration was achieved by mixing Prussian blue with safflower dye, which shifted to blue as the safflower dye faded due to light exposure. Additionally, the pink hue of the sky and the two red cartouches in this impression were likely more vibrant originally.

(**a**)



(**b**)

Figure 6. Some colours have bled through to the back of the sheet on BM1954, and it was observed that (**a**) the kimonos of two people appear blue on the recto but (**b**) purple on the verso. Both images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

UV examination of the verso of BM 1948 revealed stronger luminescence in the sky area compared to the recto, indicating that the red dye—most likely safflower—has faded and was likely far more vivid originally. Evidence of fading can be seen in other impressions. For instance, in Figure 7, the red colouration in the sky is more pronounced along the right edge, suggesting this area was shielded from light exposure and the sky in the rest of the impression originally had a more intense orange colour.

(**a**) (**b**) (**c**)

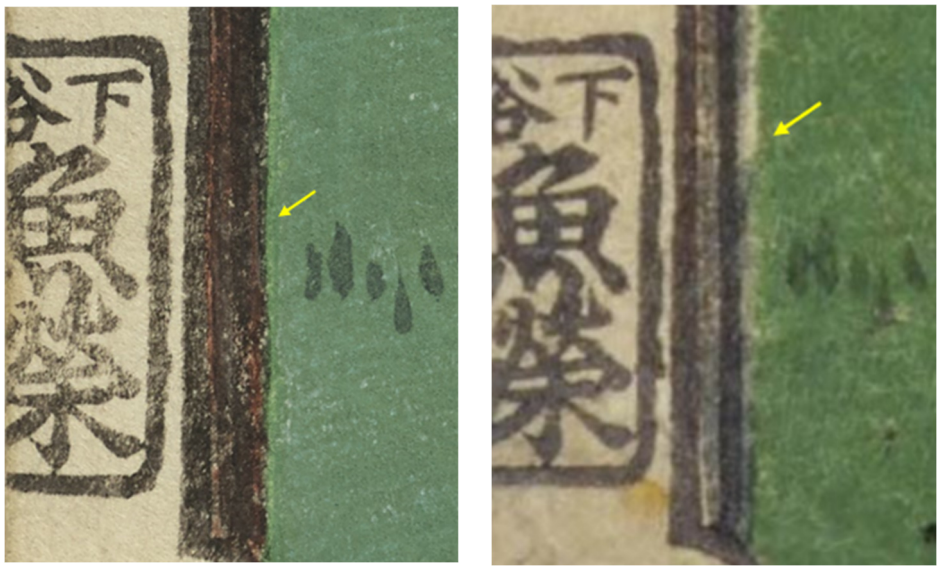
Figure 7. (**a**) In this impression, the sky appears light orange and the grass has a bluish hue. Bands along the right-hand side (**b**) and bottom edge (**c**) display more intense colours, likely due to shielding from light. Fitzwilliam Museum, accession number: P.3562-R. All images © Fitzwilliam Museum, University of Cambridge, CC BY-NC-ND 4.0.

Among the 82 impressions examined in this study, eight exhibited blue grass instead of green. This was likely due to light exposure and the fading of light-sensitive yellow colourants rather than a deliberate alteration of the colour palette. Evidence of this can be observed in the impression from the Honolulu Museum (registration number: 11490, photograph available online), and to a lesser extent in the Fitzwilliam Museum impression (Figure 7). In the Honolulu impression, small bands at the bottom and right-hand side appear to have been shielded from light, preserving their more vibrant colours. In these protected areas, the grass remains green rather than blue, and the heart of one flower is bright yellow, contrasting with the beige tone observed in the rest.

The BM 1954 and BM 1948 impressions show some degree of visual fading. The grass in BM 1954 has a blue tone compared to the greener hues observed in BM 1948 and BM 1915 (Figure 1), while the flower hearts in BM 1948 appear beige (Figure 6). Amorphous arsenic sulphide, a pigment known to be light sensitive [25], was detected in these areas. Consequently, it is likely that, as in the Honolulu impression, the grass in BM 1954 would have originally been greener, and the flower hearts in BM 1954 would have appeared yellow.

Interestingly, while the green areas in BM 1954 appear faded, the yellow areas are bright yellow. Conversely, in BM 1948, the yellow areas are significantly faded, yet the green areas are not. This difference in fading suggests variations in the yellow pigments used in each print. According to the Ukiyo-e Print Colourant Database [23], turmeric and arsenic sulphide were often used together. Turmeric is extremely light sensitive [26]. Therefore, it is possible that turmeric was used in the green areas in BM 1954 (but not in the yellow areas) and the yellow areas of BM 1948 (but not in the green areas) in combination with arsenic sulphide and has since faded completely. Note that turmeric is water insoluble and, unlike water-soluble plant dyes such as dayflower and safflower, does not bleed through paper. As a result, examining the versos of the prints does not provide evidence of its presence.

Finally, there is evidence that some impressions were retouched—this was likely carried out in the 20th century to enhance their appeal to Western collectors [27]. For instance, the green grass in the Tokyo Fuji Art Museum impression (photograph available online) seems to have been re-applied and white gaps caused by printing misalignment have been filled in the impression held by the Clark Art Institute (Figure 8).



(**a**) (**b**)

Figure 8. (**a**) Gaps due to misalignment of the blocks have been filled in this impression. Clark Art Institute, accession number: 2014.16.13, image courtesy Clark Art Institute, CC0. (**b**) Another impression that has not been retouched is provided for comparison. National Diet Library, accession number: 10.11501/1312266, CC0.

3.3. Number of Woodblocks

Fourteen distinct colours can be distinguished in the impression of "The Plum Garden at Kameido" shown in Figure 1: black, grey, red, pink, yellow, beige, three shades of green, two shades of brown and three shades of blue. In *ukiyo-e* printing, each colour typically required a separate carved woodblock. Careful examination of the printing effects reveals that some woodblocks were used multiple times. For example, the roof of the teahouse was first printed with a solid yellow colour, followed by a brown *bokashi* —a gradation effect achieved by wiping pigment from the woodblock in a controlled manner (Figure 9).

It was also determined that at least three woodblocks had been used for the tree trunks. As illustrated in Figure 10a, the light and dark grey areas on the trees do not align perfectly, indicating the use of one woodblock for the light grey and another for the dark grey *bokashi*. Additionally, as highlighted in Figure 10b, a thin green colouration can be seen on two branches in the foreground, demonstrating the use of a third woodblock. (Note: this green colouration is subtle and difficult to discern in the photograph.)

In total, as listed in Table 4, at least 16 woodblocks were used to produce the impression in Figure 1a. By comparison, the print "Under the Wave off Kanagawa" (popularly called "The Great Wave", 1831) by Hokusai was made using seven or eight woodblocks.

(**a**) (**b**)

Figure 9. Colouration of the roof of the tea house: (**a**) In BM 1954, the same woodblock was used twice: first to apply a solid yellow colour, followed by a brown *bokashi*. (**b**) In BM 1915, only a solid yellow colour was applied. Both images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

(**a**) (**b**)

Figure 10. Details from BM 1954 highlighting the use of multiple woodblocks in specific locations: (**a**) The light grey and dark grey areas on the tree do not align perfectly, indicating that two separate woodblocks were used. (**b**) Some branches in the foreground have been overprinted with a subtle green wash (note that it is difficult to discern in the photograph). Both images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Table 4. Woodblocks used for the impression shown in Figure 1.

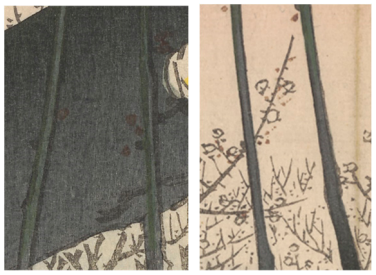
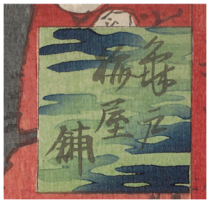
Colour	Areas	Illustrations
Black	Outlines and clothes of visitors (key block)	
Grey 1	Trees' trunks and branches, teahouse, clothes of visitors	
Green	Four thin branches in foreground	
Dark grey	Dark areas on trees (*bokashi*)	
Yellow 1	Flower hearts and roof of tea house (also used to apply brown *bokashi* on roof)	
Pink	Sky (also used for the red *bokashi* in the sky)	
Green 1	Grass (also used for the blue *bokashi* in the grass and the green *bokashi* by the fence)	
Green 2	Clothes of two visitors	
Green 3	Background of title cartouche	

Table 4. *Cont.*

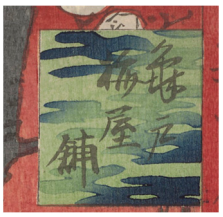
Colour	Areas	Illustrations
Red	Cartouches for artist signature and series title	
Brown 1	Wooden sign in top left corner and beam of teahouse	
Brown 2	Buds	
Beige	Benches and heads of some visitors	
Blue 1	Pattern on title cartouche	
Blue 2	Clothes of one visitor	

Table 4. *Cont.*

Colour	Areas	Illustrations
Blue 3	Clothes of four visitors	

Examination of impressions and high resolution photographs of impressions, revealed errors in block cutting (Figure 11). Additionally, the brown vertical beam beneath the teahouse roof was overprinted with dark grey, rendering it barely visible. This overprinting was likely an error as well.

(**a**) (**b**)

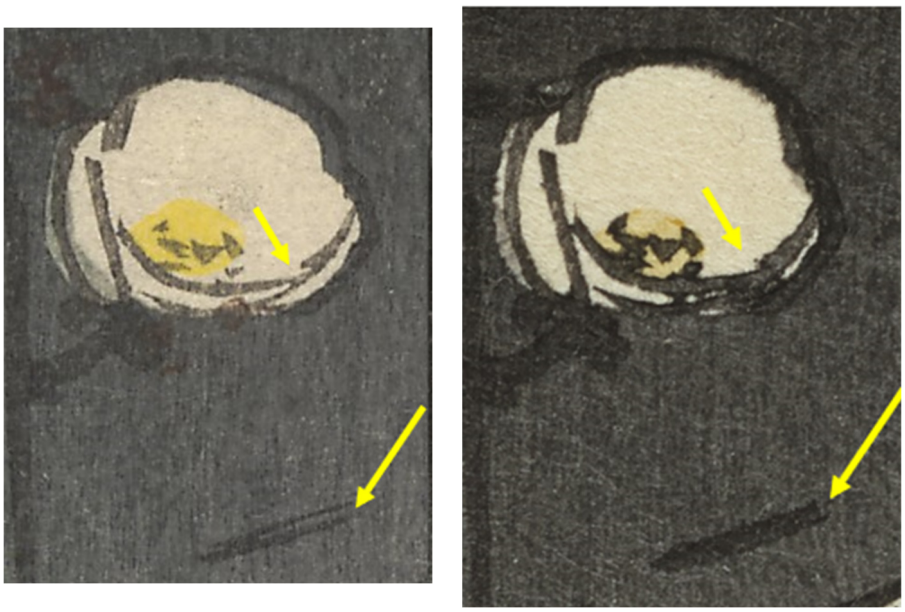
Figure 11. Examples of carving mistakes in BM 1954. (**a**) The white shapes, indicated by the red arrows, should have been filled with green. The vertical wooden beam, marked by the orange arrow, has been printed with both brown and dark grey and is only visible due to a slight offset. (**b**) In other prints depicting teahouses in Kameido, such as Hiroshige's "Complete View of the Plum Garden at Kameido" (The British Museum, accession number: 1907,0531,0.199), these beams are prominently printed (detail). Both images © The Trustees of the British Museum (CC BY-NC-SA 4.0).

3.4. Woodblock Wear Study

In general, the outlines of a design are printed from thin ridges in the key block that are particularly vulnerable to damage, resulting in small breaks in the outlines. For instance, there are numerous breaks in late-state impressions of "The Great Wave" (Figure 12).

Figure 12. Examples of breaks due to woodblock wear in Hokusai's print "The Great Wave" (The British Museum, accession number: 1937,0710,0.147) © The Trustees of the British Museum, CC BY-NC-SA 4.0.

While some impressions exhibited losses in sharpness and definition in their outlines (Figure 13), very few breaks were observed. This is surprising given the popularity of this design and the series "One Hundred Famous Views of Edo" as a whole, which may have had even more impressions printed than Hokusai's "Thirty-six Views of Mt. Fuji". Since "The Plum Garden at Kameido" was published three decades after "The Great Wave", it is plausible that technological advancements in woodblock production, such as improved seasoning of the wood, contributed to the reduced breakage.



(**a**) (**b**)

Figure 13. Difference in definition between: (**a**) an early impression (BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0) and (**b**) a later one (Clark Art Institute, image courtesy Clark Art Institute, CC0).

Striking differences in printing effects were also noted between impressions of "The Plum Garden at Kameido". While some impressions feature an entirely pink/red sky, others display a partially blue or purple sky (Figure 1). Producing impressions with the pink/red sky required an additional block and additional printing steps, making the printing process more time-consuming and costly. This suggests these were early state impressions. For instance, the thin branches in the foreground were printed with a separate green block (Figure 10b), as the green areas do not overlap with the grey areas of the trees. Similarly, blue shades are present in the grass (Figure 11a), likely achieved by applying blue ink to specific areas of the block also used for the grass. Additional effects include the brown *bokashi* gradation on the yellow roof of the teahouse, further adding to the complexity of the printing process (Figure 14). Also, the outlines of the impressions with a purple sky appear less sharp than those with an entirely red sky (Figure 1), consistent with key block wear from repeated use.

Figure 14. Brown *bokashi* on the base of one of the trees (brown arrow) and blue *bokashi* on the grass (blue arrow). BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0.

The yellow flower hearts are missing in some impressions in four distinct areas (A–D in Figure 15). In area A, as highlighted in Figure 16a, when present, the yellow heart has either a semi-circular or triangular shape.

The shapes of the hearts of the other flowers in the print remain the same in all impressions (Figure 17), so the difference in shape in area A is not due to a new yellow woodblock, but rather a local alteration in the original yellow woodblock. This modification was likely achieved using a plug: the altered section of the woodblock was chiselled out, and a replacement wooden piece, called an *ireki*, was inserted. In areas B, C and D, the yellow hearts are also missing in some impressions. The impression from the Clark Art Institute shows partial printing in area C (Figure 16b), suggesting that this section of the woodblock became warped and more challenging to print over time. For further insights into woodblock warping, the film "Hokusai Returns: Japan's Greatest Ukiyo-e Art" [28] provides additional context. In area D, the yellow heart is particularly small (Figure 18) and, while present in some later impressions (e.g., BM 1915), it is absent in several early

impressions, such as an early impression in the Tikotin Museum collection (photograph available online). This suggests that the omission of this small yellow area was not due to its removal from the woodblock but was instead likely the result of a printer overlooking it during the inking process due to its size.

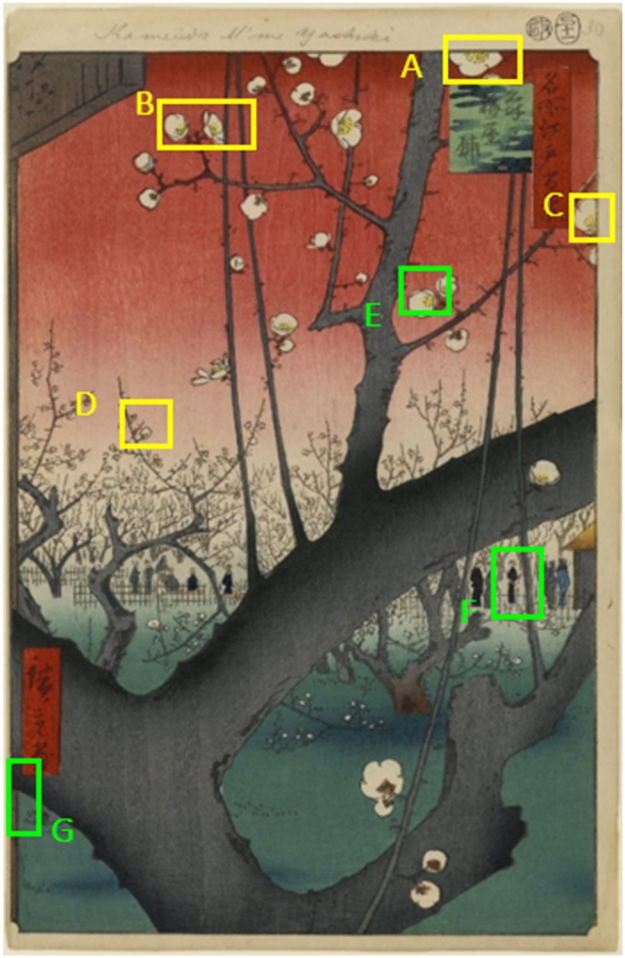


Figure 15. Areas of the print discussed in the text. In some impressions, the yellow hearts of flowers (A–D) are missing. Other impressions have printing variants in certain areas (E–G). BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0.

Two anomalies in the sky were identified in some impressions, specifically in areas A and E (Figure 15). In area A, a small triangular area is blue rather than purple like the rest of the sky because of a carving mistake in the red woodblock (Figure 19a,b). In area E, a small area of the sky above a flower was left unprinted (Figure 19c,d). These defects indicate that an additional woodblock was cut to apply red, and it contained imperfections. The reason for producing this new woodblock is unclear, as the original red woodblock was still used to apply blue ink to the sky. One possibility is that the new red block was created to eliminate the need to clean the original block when switching between red and blue inks. Notably, the new red woodblock appears to have incorporated the red series title cartouche (top right of the print) and the artist's signature cartouche (bottom left) (Figure 20). This may have helped reduce the white gaps along the red cartouches caused by the warping of the original woodblocks, thereby improving the overall appearance of the impressions.

Figure 16. (**a**) In area A, the flower heart has a semi-circular or triangular shape or is missing (from top to bottom: BM1954, BM1948 and BM 1915). (**b**) Partial printing of the yellow heart in area B. (**c**) Absence of yellow hearts for flowers in area C. (**d**) Absence of yellow heart for the flower in area D (Clark Art Institute, images courtesy Clark Art Institute, CC0).

Differences in brown details were observed among impressions in areas F and G. In area F, the *obi* (sash) of one figure's kimono was printed in brown in a small number of impressions—at least 12 (this detail could not be confirmed in impressions without high-resolution photographs)—but left unprinted in most impressions (Figure 21). While the brown *obi* is present in some later impressions (e.g., Art Institute of Chicago (AIC) 1965.1027, photograph available online), it is absent in a few early impressions (e.g., Honolulu Museum 22721, photograph available online). This suggests that its omission was not due to its removal from the brown woodblock but an oversight from the printer due to its small size. In area G of most impressions, brown was applied alongside dark grey to represent the pole of the wooden sign, partially visible along the left edge of the print. (Note that in some impressions this brown colouration is very faint and difficult to detect.) The small section at the top of the pole below the red cartouche is flat in most impressions but appears triangular in some later ones, suggesting a modification to the brown woodblock (Figure 22).

(**a**)

(**b**)

Figure 17. The shapes of the yellow flower hearts are identical in early and late impressions: (**a**) an early impression (BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0) and (**b**) a late impression (Clark Art Institute, image courtesy Clark Art Institute, CC0).

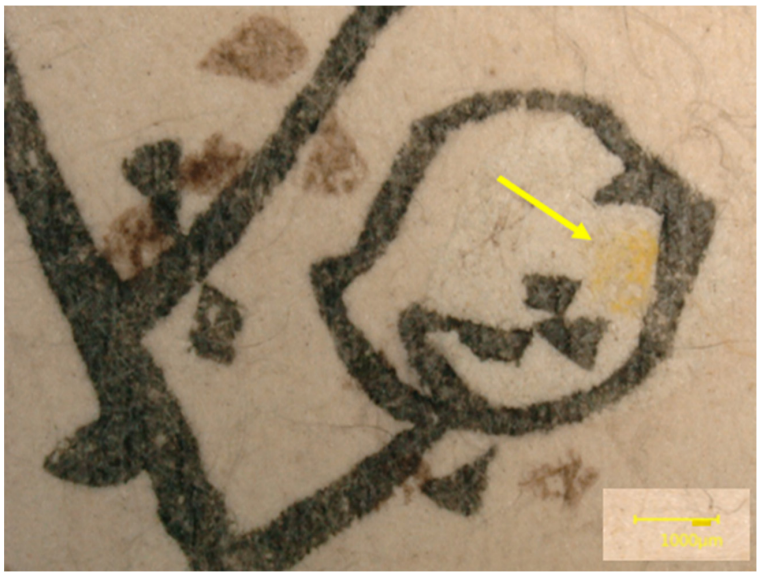
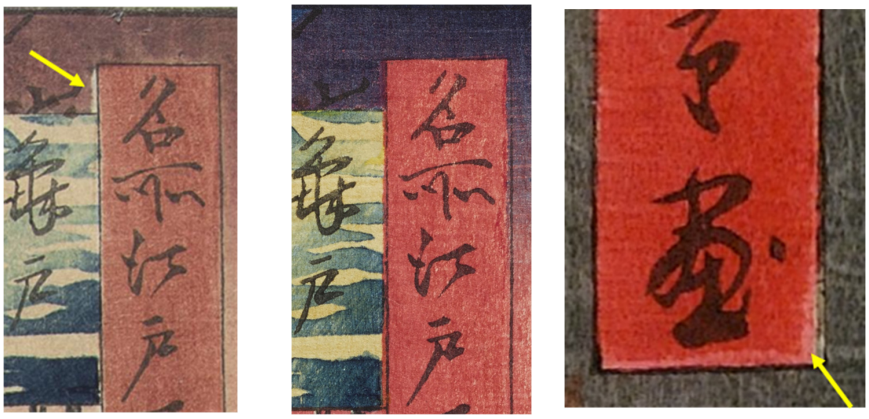


Figure 18. The yellow flower heart in area D in Figure 15, when present, is very small-less than 1 mm in diameter (BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0).

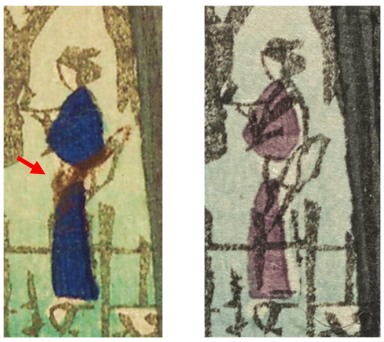
(**a**) (**b**) (**c**) (**d**)

Figure 19. In some impressions, imperfections were noted for the areas printed with red/pink ink: (**a**) In area A, a small triangle has been left blue while the rest of the sky is purple (BM 1915). (**b**) Other impressions do not show this anomaly (BM 1954). (**c**) In area E, a small triangle is white (BM 1915), (**d**) unlike impressions made with the original woodblock (BM 1954). All images © The Trustees of the British Museum, CC BY-NC-SA 4.0.



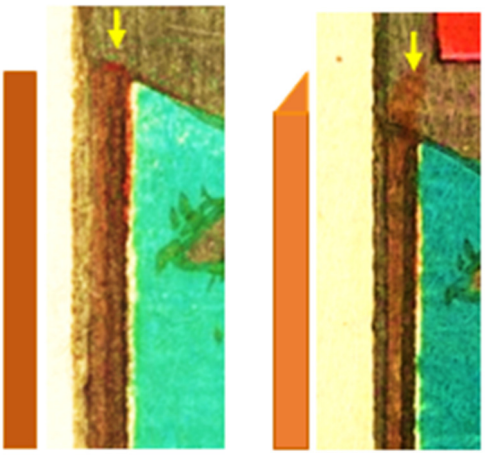
(**a**) (**b**) (**c**)

Figure 20. The new red woodblock seems to have included the sky as well as the two red cartouches (top and bottom of the print), unlike the original red woodblock. (**a**) Detail of an impression printed using the original red block showing a white gap between the sky and the red cartouche (Chazen University of Wisconsin, accession number: 1980.1608, Bequest of John H. Van Vleck, CC0). (**b**) Detail of an impression printed with the new red block—there is no gap between the sky and the cartouche (Clark Art Institute, image courtesy Clark Art Institute, CC0). Note that there is also a separate block for the red cartouches, and it was used on all impressions. (**c**) In late impressions, the deep red printing from the cartouche block and the lighter red printing from the new woodblock can be distinguished, as they do not align perfectly (Clark Art Institute, image courtesy Clark Art Institute, CC0).



(**a**) (**b**)

Figure 21. (**a**) The brown *obi* is printed in some impressions (BM 1954 © The Trustees of the British Museum, CC BY-NC-SA 4.0) but (**b**) left unprinted in most of them (Clark Art Institute, image courtesy Clark Art Institute, CC0).



(**a**) (**b**)

Figure 22. Variation in the shape of the brown block used in area for the sign's pole in the foreground of the print in the bottom left corner (the colours of the photographs have been enhanced and a schematic representation added for clarity): (**a**) the extremity of the brown shape is flat (AIC, accession number: 1965.1027, CC0); (**b**) the extremity is triangular (BM 1915 © The Trustees of the British Museum, CC BY-NC-SA 4.0).

3.5. The Four States of Hiroshige's Design

Based on the woodblock wear, four different printing states of "The Plum Garden at Kameido" were distinguished, as outlined in Table 5. Among the assessable impressions, state 2 was the most common, with 23 impressions. State 1 included 18 impressions, state 3 had 13 and state 4 comprised 20 impressions. First-state impressions are characterised by blue *bokashi* effects in the grass and a brown *bokashi* on the roof of the teahouse. The yellow flower heart in area A has a semi-circular shape and the title cartouche has a green background (Figure 23). While first-state impressions have a deep red *bokashi* at the top of the sky, the presence of a red sky alone is not definitive evidence of the first state, as a small number of later-state impressions also feature red skies (e.g., AIC 1965.1027, photograph available online).

Table 5. The four printing states of "The Plum Garden at Kameido".

State	Characteristics	Examples
1	Blue *bokashi* in grass, brown *bokashi* on the teahouse roof, circular shape of flower's heart in area A, red sky, green title cartouche background	BM 1954, Rijksmuseum, Tikotin Museum
2	Triangular shape of flower's heart in area A	BM 1948, Fitzwilliam Museum, Chester Beatty Library
3	Missing flower's heart in area A (sometimes in other areas as well)	Chazen University of Wisconsin, Shimane Museum
4	Blue/purple at top of the sky, missing flower's heart in area A (sometimes in other areas as well), yellow title cartouche background cartouche, use of new red woodblock as seen by small defects in areas A and E	BM 1915, National Diet Library

In second-state impressions a correction was made to the yellow woodblock in area A, resulting in the flower heart shape changing from semi-circular to triangular (Figure 16a). These impressions typically have a blue or purple *bokashi* at the top of the sky, with the title cartouche retaining its green background.

(**a**) (**b**)

Figure 23. (**a**) The background colour of the square title cartouche is green in first and second-state impressions (BM 1954) and (**b**) yellow in fourth-state impressions (BM 1915). Both images © The Trustees of the British Museum, CC BY-NC-SA 4.0.

For third-state impressions, the yellow heart in area A is no longer printed. The sky may be entirely red, but more commonly features a blue or purple *bokashi* at the top like second-state impressions. The background of the title cartouche varies between green and yellow.

In fourth-state impressions, a new red woodblock was introduced to print the sky and the two rectangular cartouches. This addition improved the printing by reducing unprinted gaps caused by misalignment, likely resulting from the warping of the original blocks over time. However, it inadvertently omitted small sections in areas A and E, leading to colour discrepancies. These errors suggest the block was prepared in haste. In these impressions, the title cartouche background is yellow.

Of the 82 photographed impressions analysed, it was not possible to determine the state of eight impressions due to the low-resolution of the photographs (e.g., Isago no Sato Museum), extreme fading (e.g., Honolulu 11490) or trimming (e.g., AIC 1939.1405).

4. Conclusions

Few in-depth investigations have explored the evolution of specific designs over time. The study of 82 impressions of Hiroshige's "The Plum Garden at Kameido" highlights the complexity of the *ukiyo-e* printing process. Comparative analysis uncovered significant variations across printing states, driven by differences in woodblocks, block wear, colourants and printing techniques. Four distinct printing states were identified, each reflecting evolving production methods and modifications to the original design.

Early impressions, which most faithfully preserve Hiroshige's artistic vision, are characterised by a greater number of printing steps, intricate *bokashi* effects and minimal woodblock wear. In contrast, later states show reduced printing complexity, cutting mistakes in new block, misalignment and colour alterations—clear evidence of the pressures of mass production and the commercial decisions made by publishers. In addition, evidence of fading was observed in several impressions, suggesting that the original colours were likely more vibrant.

This study underscores the value of detailed comparative analyses in fully understanding the material and artistic complexity of *ukiyo-e* prints. Further studies of this kind are essential to better understand the technological, artistic and commercial factors that shaped *ukiyo-e* print production.

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Abbreviations

The following abbreviations are used in this manuscript:

AIC	Art Institute of Chicago
BM	British Museum
FORS	Fibre optic reflectance spectroscopy
UV	Ultraviolet
XRF	X-ray fluorescence

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