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Reflections on the Suger Chalice

New Observations and Technical Analysis

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The *Chalice of the Abbot Suger of Saint-Denis* (1942.9.277; hereafter *Chalice*) is one of the greatest treasures of European medieval art in American collections (figs. 1–6). Today, in its display case at the National Gallery of Art, the *Chalice*, with its beautifully banded stone cup and bejeweled mounts, appears eternal and unchanging. However, the history of this precious vessel is one of transformation in both substance and purpose. Prior discussion has largely focused on its prominent patron, leaving many details about its materials and condition unstated and uncertain. The aim of the present collaborative study was to provide this fundamental information through visual examination and scientific analysis. These results were then considered alongside period documentation to assess the current condition of the *Chalice* and recognize what changes have occurred and when. This comparison also revealed ambiguities and inaccuracies in the early documentation, creating challenges for identifying the likely original appearance of the vessel. Consideration of its precious materials and their origins presented a new perspective on the *Chalice*, offering a glimpse into a larger history of early trade networks and connections to distant lands.

Fig. 1. Chalice of the Abbot Suger of Saint-Denis, Alexandria, 200–1 BCE (cup); Paris before 1149 (mounting), h: 18.4 cm; diam. (base): 11.7 cm, (top): 12.4 cm, National Gallery of Art, Washington, Widener Collection, 1942.9.277. View of front.

Fig. 2. Back of Suger Chalice (fig. 1).

Fig. 3. Right side of Suger Chalice (fig. 1).

Fig. 4. Left side of Suger Chalice (fig. 1).

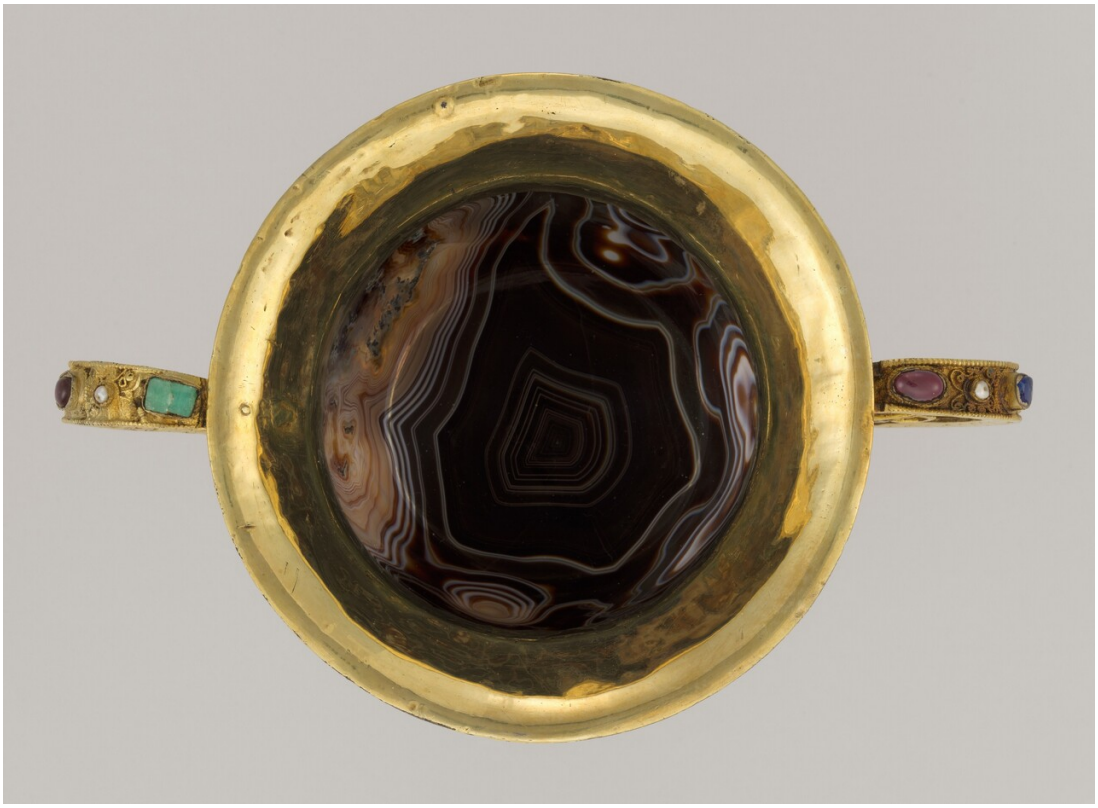

Fig. 5. Top view of Suger Chalice (fig. 1).

Fig. 6. Underside of Suger Chalice (fig. 1).

History and Documentation

The *Chalice* was documented a number of times while at the Abbey of Saint-Denis. In the years prior to his death in 1151, the Parisian cleric Abbot Suger wrote about his contributions to the treasury, including "a precious chalice made of a block of sardonyx," which scholars have associated with the vessel.[1] Suger saw display as central to the function of the *Chalice* and the other objects he acquired; in his will of 1137, he specified that textiles and "ornaments of gold and silver be displayed, whether in mass or as it pleases them [the brothers]."[2] The vessel is first definitively identified as a gift of the abbot in a history of Saint-Denis from 1625.[3]

The *Chalice* is described in detail in a 1634 inventory of the church, which has been the subject of extensive research.[4] This document has been characterized as "as much an audit as an inventory," with a particular focus on the valuation of objects.[5] Among the inventory's authors were goldsmiths, as reflected in their specific observations regarding materials and techniques that sometimes neglect iconography.[6] The inventory offers some evidence prior to the seventeenth century, as it drew heavily upon a 1534 inventory and a 1504 summary of the collection.[7]

A watercolor from 1633 offers an early visual record of the *Chalice*. The illustration was created in 1633 by Daniel Rabel at the commissioning of Nicolas-Claude Fabri de Peiresc, who was interested in the antique objects at Saint-Denis, including the *Chalice*'s cup (fig. 7).[8] However, close comparison of this image with the

vessel itself, carried out in the present study, identified many differences and made it clear that the watercolor must be understood as an artistic impression rather than a documentary reproduction. The vessel was recorded again in 1706, appearing among the treasures of Saint-Denis in an engraving by N. Guerard from a volume by Michel Félibien (fig. 8).[9] Though this image is small in scale and lacks color, it offers insights into the condition of the *Chalice* at that time. The vessel would last be recorded at Saint-Denis in 1783.[10]

Fig. 7. Daniel Rabel, Watercolor of Suger's Chalice, 1633, watercolor, Cabinet des Estampes, Bibliothèque nationale de France, Paris.

Fig. 8a. Nicolas Guérard, engraving from Michel Félibien, Histoire de l'abbaye royale de Saint-Denis en France (Paris, 1706).

Fig. 8b. Detail of Suger Chalice.

In the wake of the French Revolution, the *Chalice* and other treasures from Saint-Denis were nationalized and, in 1791, put on public display at the Cabinet des Médailles, Bibliothèque nationale de France. On February 16, 1804, the vessel was among the group of objects stolen from the Cabinet.[11] In London, on July 20 of that same year, the thief showed the vessel to Charles Townley (1737–1805), who purchased it five days later.[12] By 1838, it was known in France that the vessel had been smuggled out and sold into Townley's collection.[13] The *Chalice* is presumed to have remained with the Townley family until around 1920, when it was purchased by the London dealer Harry Harding.[14] Marc Rosenberg saw the vessel in London in 1921 and recorded his "rediscovery" in a handwritten text that included the first modern images in which the vessel appears in its present condition (fig. 9).[15] Passing through the Goldschmidt Galleries in New York, the *Chalice* was acquired in 1922 by the Philadelphia-based collector Joseph E. Widener, and the following year it was first published in that collection.[16] In 1942, the medieval treasure was included in Widener's bequest to the newly established National Gallery of Art.[17]

Fig. 9. Photograph of Suger Chalice (fig. 1), from Marc Rosenberg, "The Chalice of the Bishop Sugerius from St. Denis," 1921–1930, library, National Gallery of Art, Washington.

The first technical examination of the *Chalice* was undertaken in 1974, when it was transported to the Freer Gallery for x-radiography.[18] This investigation marked an important moment as it was determined that, in addition to exhibition loans, technical study could justify movement of works outside the National Gallery.[19] Study of the vessel continued in 1976, when a visiting glass scientist recognized the beads of white glass among the pearls and offered preliminary identifications of the decorative stones.[20] In 1977, an outside mineralogist visually examined the vessel, confirming the cup as sardonyx and providing more specific identifications of the gems.[21] Unfortunately, nearly all of this research has failed to enter the literature on the *Chalice*.[22]

Methods

In the present study, complementary methods were used to identify the materials comprising the *Chalice*. An intensive visual examination was undertaken that included new high-resolution images and digital microscopy.[23] New digital x-radiographs were taken to reveal the internal structure of the vessel.[24]

Elemental analysis of the cup, mounts, and applied ornament was performed with two x-ray fluorescence (XRF) spectrometers, a Bruker Tracer 5 g and a Bruker M6 Jetstream. Point analyses with the Tracer were performed on the sardonyx, gemstones, and pearls using a method for geological samples.[25] On the mounts, a method for precious metals was used.[26] Analyses with the Jetstream were carried out in collaboration with Kathryn Morales, conservation scientist at the National Gallery. Elemental maps were captured of selected areas, and additional points were analyzed in locations inaccessible to the Tracer.[27] The sardonyx and a selection of gemstones and pearls were analyzed using Raman spectroscopy in collaboration with Joan Walker, conservation scientist at the National Gallery.[28]

Cup

Consideration of the Suger *Chalice* must begin with the delicately carved and highly polished stone cup that lies at its heart. Abbot Suger himself described it as "sardonyx," an identification confirmed by prior visual examination and scientific analysis in the present study.[29] The dramatically veined stone consists of nearly pure silica (table 1).[30] Raman spectroscopy identified peaks associated with microcrystalline quartz, which has a triclinic structure, as well as moganite, a monoclinic form of silica.[31] These observations are consistent with agate, a banded type of cryptocrystalline silicate stone, which most commonly forms within geodes as silica-rich fluids deposit over millions of years in cavities within volcanic rock.[32] Agates that form with parallel bands of reddish-brown and white are commonly known as "sardonyx."[33] Small areas of dark material trapped within the stone are presumably remnants of the volcanic crust that once surrounded the banded stone (fig. 10).[34] XRF mapping identified these inclusions as primarily iron, with small amounts of copper and potassium, a trace of titanium, and possible traces of manganese, lead, rubidium, and zirconium.[35] Calcium and lead detected around the borders of the inclusions are likely associated with a fill material used to repair small voids in the stone. The date of the repairs is unclear, but they presumably occurred before entering the National Gallery's collection.

Table 1. Results of XRF and Raman analysis of sardonyx

Sample	XRF	Raman (532)	Raman (785)	Mineral ID	Comment
dark bank	**Si**	**463**, 207, 127, 501*	**464**, 205, 503*	microcrystalline quartz	*moganite
light band	**Si**	**464**, 204, 127, 502*	**464**, 209, 354, 503*	microcrystalline quartz	*moganite
inclusion	**Fe**, **Cu**, Pb, Rb, Zr, K, Ti				

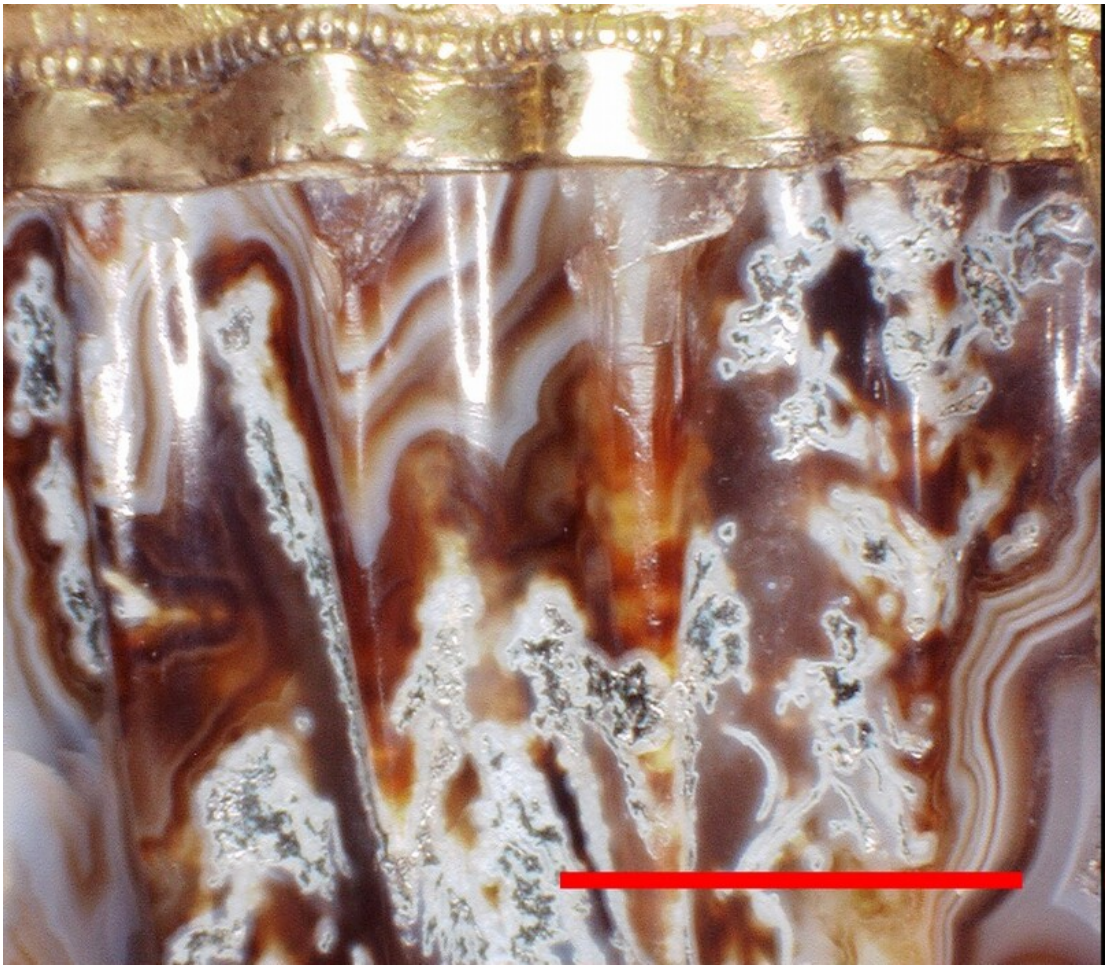

Fig. 10. Detail of Suger Chalice (fig. 1), sardonyx cup with metallic inclusion (bar = 0.5 mm).

Hardstone vessels like the sardonyx cup were luxury goods used by the ancient Roman elite for secular banqueting or offering libations to the gods.[36] Although antique sources of sardonyx existed in Europe, mines in India were known to produce high-quality banded agates, which were transported to Egypt by Arab caravans.[37] Future analysis of other ancient sardonyx objects, considering their metallic inclusions and crystalline characteristics, could offer insight into the source of the *Chalice*'s stone.[38] The exceptional quality of the sardonyx cup suggests it was carved between 200 and 1 BCE in the Egyptian city of Alexandria, known for its skilled working of hardstones.[39] Although the level of carving on the vessel is unique, comparisons can be drawn with certain other objects, including a sardonyx bowl at the Getty Museum dated 300–100 BCE (fig. 11).[40] The stone was hollowed and shaped with great difficulty, using a grinding wheel coated with a slurry of harder grit, such as corundum.[41] The carver, when envisioning the form of the cup within the stone, took care to position the concentric bands so that they would encircle the bottom. The visual effect of the stone is reflection enhanced by the high polish and delicate fluting; even intense modern light sources will only pass through the thinnest areas.

Fig. 11. Bowl, Qift (Egypt), 300–100 BC, J. Paul Getty Museum, 72.AI.38.

The current condition of the sardonyx cup speaks to its careful preservation by a succession of owners from antiquity until merchants brought it to Paris in the first half of the twelfth century where it was purchased by Suger.[42] Comparison to the other vessels commissioned by Suger supports the conclusion that he was responsible for the transformation of the secular antiquity into a sacred object by the addition of precious metal mounts. At that moment, the front of the vessel was established by the position of the central medallion on the foot; the sardonyx had not previously had a preferred orientation. The positioning of the mounts appears to have been influenced by the inclusions in the stone, with the metalwork placed such that the larger dark areas are at the back or behind the left handle. The mounts also helped conceal small chips around the rim, as well as minor losses from the fluting (see fig. 10).[43] While trimmed, the stone surface in these areas remains slightly rougher than in adjacent areas, which suggests that the cup was not repolished overall by the medieval artisans or in subsequent centuries.[44] However, given the many centuries that have passed since carving, it is difficult to state definitively that the sardonyx retains its original finish.

The 1633 watercolor included a small foot on the sardonyx cup of a type that could have been present on such an ancient vessel (see fig. 7). This detail may have been invented by the artist to make the ancient cup—his primary focus—appear complete, possibly drawing upon knowledge of similar objects. As depicted in the watercolor, the relationship between the cup and the knob makes little sense; the metalwork would certainly be attached by wrapping around the foot if one were present. However, the foot could have been exposed if the mounts were removed, a possibility strongly suggested by letters from 1633 between Nicolas-Claude Fabri

de Peiresc and Denis Guillamin.[45] No evidence of a foot is visible in the small gaps between the fluted lower surface of the cup and the knob. The x-radiograph also offers no indication; however, it is difficult to image lower-density stone within the surrounding metal.[46] It remains unclear exactly how the cup is attached—most likely using cement, possibly surrounding a smaller, fragmentary foot; the handles also help link the upper and lower mounts.

Mounts

The metalwork on the vessel is of exceptional quality and notable for its use of double filigree, where the intricate decoration of the surface is formed by a pair of parallel beaded strands rather than a single strand.[47] Based on this and other technical details, the *Chalice* can be associated with two other objects given by Suger to Saint-Denis: the *Eleanor Vase* (fig. 12) and a *Sardonyx Ewer* (fig. 13).[48] The mounts on all three vessels were likely produced in the years just prior to 1149 based on the documented history of the *Vase*. Eleanor of Aquitaine (d. 1204) gave the unmounted rock crystal to her husband, Louis VII of France (d. 1180), sometime between their marriage in 1137 and when Suger first mentioned receiving it from Louis in his De Administratione, which he continued revising until 1148–1149.[49] Writing in 1152, Suger's biographer described how the abbot had brought in expert craftspeople from all parts of France, including goldsmiths and jewelers.[50] Although the names of the artisans who prepared the mounts for these three vessels in the twelfth century remain unknown, their highly specific shared features argue for their creation in a Parisian workshop.[51]

Fig. 12. Eleanor of Aquitaine Vase, Iran, 500–700 (rock crystal); France before 1147 (gilded silver mounts with filigree, gemstones, pearls, niello and champlevé enamels), Musée du Louvre, MR 340.

Fig. 13. Sardonyx Ewer, Byzantine, 600–700 (sardonyx); France before 1147 (gilded silver mounts decorated with filigree, gemstones, pearls, and niello), Musée du Louvre, MR 127.

The most detailed early record of the mounts on the *Chalice* is offered by the 1633 watercolor. The inventory offers little insight but does provide the overall weight. In 1634, the vessel was recorded as three marks, seven and a half ounces, or roughly 960 grams; today the weight is 1024 grams.[52] The inventory and other early documents do specify that the mounts, including those on the cup, handles, stem, and foot, were made of gilded silver.[53] XRF analysis confirmed that all of the metalwork includes gold and mercury, associated with fire gilding, over an alloy of nearly pure silver with a small amount of copper.[54] An unusual detail is the presence of gilding on the underside of the foot, which speaks to the vessel's function; as the priest raised it during a religious service, the bottom would become visible. The delicate filigree decoration was also identified as gilded silver; in XRF maps the underlying alloy was revealed on high points of the design where the gold layer is thinner (fig. 14). The examination also identified a thin iron-rich layer that was applied over most but not all of the gilded surface.[55] This would impart a warmer tone, possibly intended to counter the cooler silver color beneath the gold. The twelfth-century treatise by the author known as Theophilus included a method for coloring gilding with an iron-containing pigment.[56]

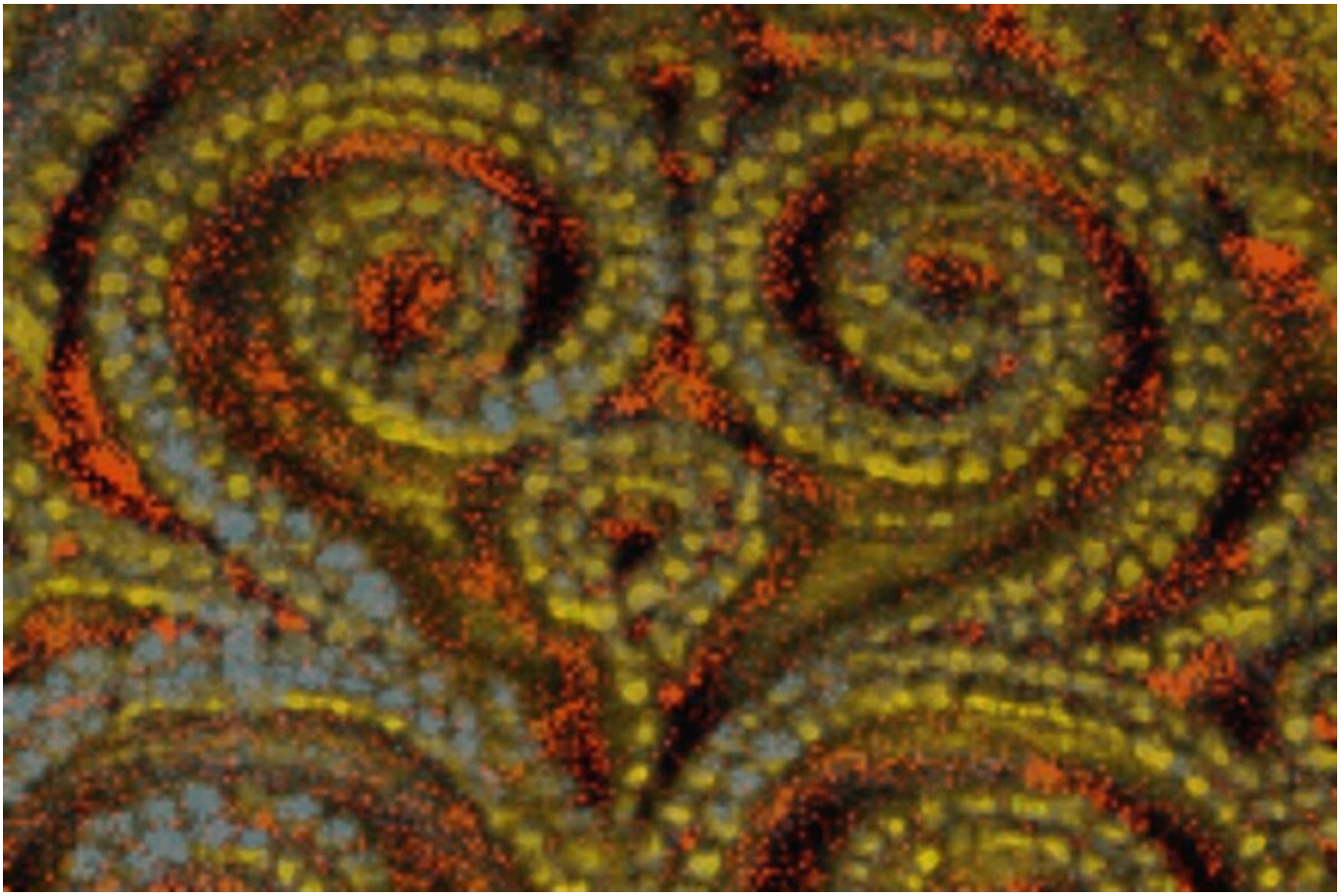

Fig. 14. Detail of filigree on upper foot of Suger Chalice (fig. 1), false color XRF elemental map of gold (yellow), silver (gray), and iron (red).

Gemstones and Pearls

The mounts of the *Chalice* are richly decorated with applied ornament that encircles the upper border, knob, stem, and foot. Previous literature has sometimes misidentified the gemstones or given the impression that many were replaced with glass.[57] Using XRF and Raman analysis, the present study clearly identified the gemstones, pearls, and other materials currently on the vessel (see table 1). Of the forty-two larger colored settings, thirty-four are gemstones: twenty-five garnets, five beryls, three sapphires, and one chalcedony. Of the fifty-nine smaller white settings, fifty are pearls and nine are white glass beads. These results largely confirm the earlier unpublished technical examinations while shedding further light on the elemental compositions and variations found within the applied ornament.[58]

Table 2. Results of XRF and Raman analysis of gemstones (S) and pearls (P)

	Sample	Identification	XRF	Raman (532)	XRF (785)	Mineral identification	Probable date	Comment

DRAFT PDF: TABLE 2 FORMAT STILL IN REVIEW

Garnets consist of a family of minerals that can vary considerably in elemental composition. Those on the *Chalice* are primarily oxides of iron, silicon, and aluminum, with smaller amounts of magnesium, calcium, and manganese; these are present mostly as the mineral almandine ($Fe_3Al_2Si_3O_{12}$), with smaller amounts of other minerals.[59] Although further analysis is needed, the high levels of iron and the absence of significant chromium are inconsistent with garnets from Bohemia but suggest an origin in India, which has been identified as a source of these gemstones on other medieval European objects.[60] Beryls consist of oxides of silicon, aluminum, and beryllium; although the latter could not be detected by XRF, this mineral was confirmed by Raman spectroscopy.[61] Although chemically identical to emeralds, beryls are whiter and more opaque. Sapphires are nearly pure aluminum oxide present as the mineral corundum, while chalcedony is nearly pure silicon dioxide in the form of microcrystalline quartz.[62]

Of the eight remaining "stones" on the *Chalice*, seven are glass: four green, two red, and one blue (see table 1). All contained potassium and calcium, sodium was below the limit of detection for the method used, and none of the glasses are leaded. The green glasses are colored by copper, the blue glass has a trace amount of cobalt, and the red glass has a small amount of manganese. One setting on the foot was found not to be stone or glass but a reddish-brown resin filling the bezel, presumably intended to suggest a garnet.

Within the decorative program of the *Chalice*, the colored settings are complemented by fifty that hold pearls and nine that have been replaced over time with white glass (see table 1). The pearls can be recognized by their slightly irregular shape and layered structure. They vary considerably in color, with the majority having a warm beige tone and the others ranging from yellow-white to dull gray. The pearls consist primarily of calcium present in the mineral aragonite, which was confirmed by XRF and Raman spectroscopy. An elevated trace of manganese detected by XRF suggested two pearls came from a freshwater source (see table 1).[63] The 1634 inventory indicated pearls of different origins were already present in the seventeenth century, described as "oriental"—which would be salt water—and "Scottish"—which would be freshwater.[64] Many of the pearls have drilled holes, which may have been part of their standard preparation and does not necessarily indicate reuse.[65] Pearls must also have reached medieval Europe undrilled, as Theophilus described the method for

piercing them.[66] Presumably, the drilled pearls would originally have been oriented so as to conceal these holes; the many now visible suggest that pearls have been reset or replaced. On close examination, the glass beads appear opaque, bright white, and spherical with small pits on the surface as a result of bubbles.[67] The glasses consist primarily of silicon with calcium and potassium, with antimony present as an opacifier, although the elemental content and the opacity vary considerably.[68]

The analyses clearly reveal the nature of the applied ornament and, in some instances, suggest a place of origin. However, other sources of information are needed to understand when a particular stone, pearl, or other decoration may have been added to the *Chalice*. Some clues are provided by visual examination of the individual settings and the surrounding metalwork. In the medieval period, gemstones were prepared with simple cuts, primarily as slightly domed cabochons or rectangular tablets with slightly beveled edges. Complex cuts with multiple facets, notably the rose cuts on certain stones, reflect technical developments that occurred during the Renaissance and later periods.[69] The filigree was designed with spaces reserved for the applied ornament and offers evidence of their original position and number. Later alteration or reheating readily damaged the fine filigree, thus providing a record of changes. The bezels for the settings also offer evidence about their history. The finely scalloped bezels are likely original, as they resemble the settings on the better-preserved *Eleanor Vase* and *Sardonyx Ewer* (see figs. 12, 13).[70] The heavy flat strips around other settings are clearly inconsistent with the high quality of the original metalwork. However, questions remain for the gems. An old stone can be reset in a new bezel or an old setting carefully opened to insert a new gem.

The 1634 inventory offers detailed lists of the applied ornament—gemstones of various types, glass, and pearls—on each register of the *Chalice*, but while the materials are specified, the exact positions are not. The inventory paid little attention to the gilded silver mounts beyond the overall weight, focusing on the vessel's value rather than its artistry. The watercolor created in 1633 offers more insight into the decoration and form of the metalwork but only records one side, and the identification of the ornament is suggested only by its color and shape. Furthermore, this illustration was prepared for a publication on antiquities, so great attention is paid to the sardonyx cup, while the mounts remain somewhat generalized. To understand the history of the decoration of the *Chalice*, these period sources must be reviewed alongside observations on the current condition of each section of metalwork—the upper border, knob, and foot. This process offers insights into how the vessel has changed, revealing what can and cannot be said about its original appearance in the twelfth century.

Upper Border

The upper border on the *Chalice* is decorated with an alternating pattern of large gemstones and pairs of pearls surrounded by filigree (fig. 15). This type of decorative scheme was described by Theophilus and resembles that found on many other medieval vessels and decorative objects.[71] Visual examination suggests that the metalwork of the upper border is little changed. The characteristic double filigree is clearly legible and well preserved, except for some localized loss of detail that likely occurred during alteration of the bezels. The form of the border closely resembles the 1633 watercolor, with the notable exception of the latter's inclusion of a double beaded border just above the bottom ribbon (see figs. 7, 15). While gaps are visible now around parts of the ribbon, removal of one row of this finely worked border seems unlikely, leaving an error in the watercolor as the likeliest explanation.

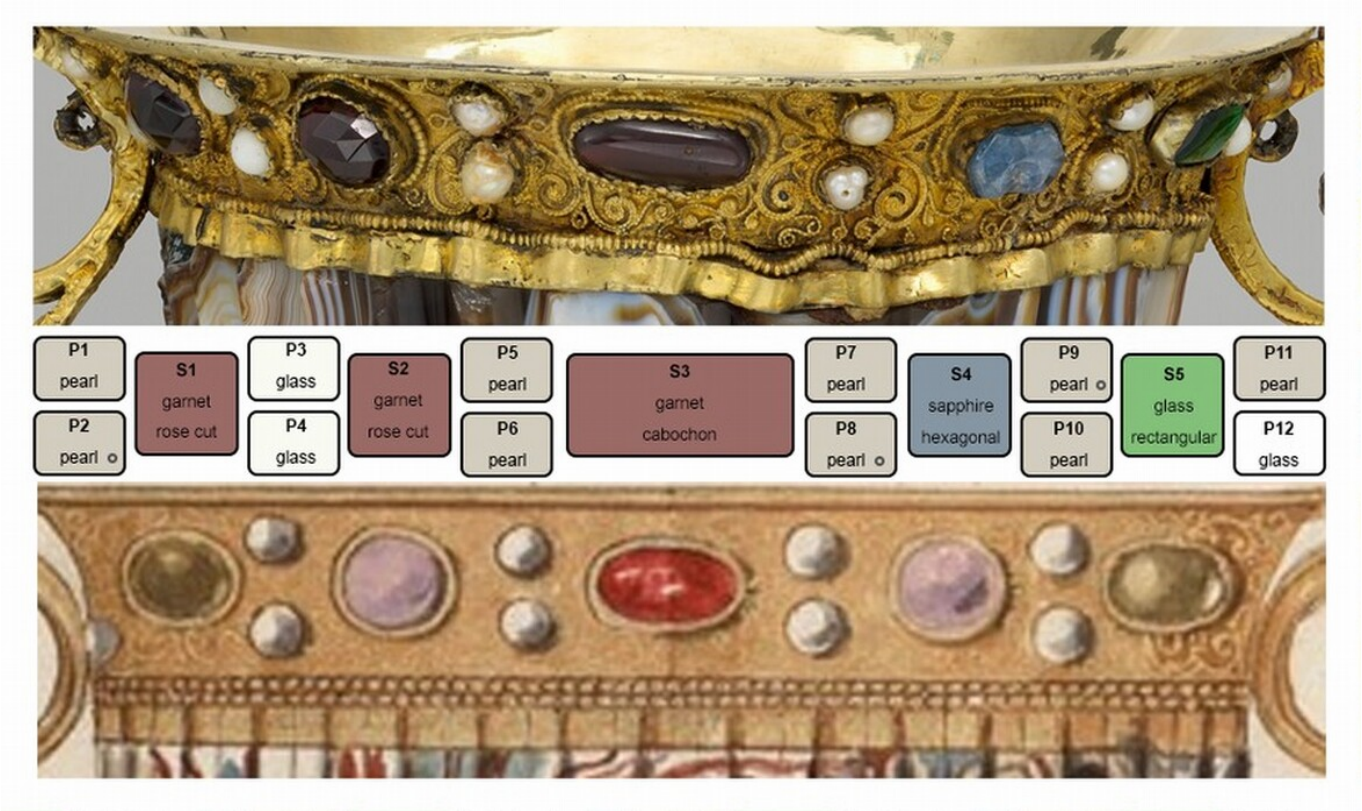

Fig. 15. Top: detail of upper border on front of Suger Chalice (fig. 1); middle: identification of applied ornament (circles indicate drilled pearls); bottom: detail of Rabel, Watercolor of Suger's Chalice (fig. 7).

The filigree on the upper border reserves positions for ten large settings, consistent with the number indicated by the seventeenth-century inventory and watercolor. However, of the ten listed in the inventory, only three might correspond to those now on the vessel.[72] Most convincing is the oval-shaped garnet at the center front. Its cabochon cut and finely scalloped bezel support an early date, as does the representation of a similar red stone in the watercolor.[73] The inventory also mentions a "presine de petite valeur," which refers to a green stone of less value than an emerald, possibly a beryl.[74] The rounded, rectangular beryl on the back of the upper border could be medieval in date, although its altered bezel raises doubts about whether it could have been reset, moved, or added later (see fig. 2). The green glass on the front of the upper border could also have been present in 1634; four glass settings were mentioned in the inventory, but their color was not specified (see fig. 15). This glass could also correspond to a greenish one on the watercolor in the same position, although there it is illustrated as a generic circle. The presence of glass might not necessarily indicate replacement; it might have been included originally where an intense, transparent green was desired.[75]

Seven of the stones on the upper border have been changed since the seventeenth century. In addition to three missing glass settings, none of the four amethysts listed in the inventory remain. Their positions in the seventeenth century are suggested by pale purple circles in the watercolor (see fig. 7). Two sapphires now present on the upper border could be medieval in date based on their cut and appearance.[76] The five rose-cut garnets now on this border cannot be medieval and were likely added after the seventeenth century (see fig. 15). The removal and replacement of the stones is consistent with the use of treasury objects as assets, where withdrawals and deposits would be made as needed.[77]

Complementing the ten large stones on the upper border are pairs of smaller settings that now hold sixteen pearls, six beads of white glass, and two small garnets (see table 1; figs. 2, 15). The 1634 inventory listed twenty-four pearls (with a note in the margin that one was missing), suggesting that the glass and garnets were added later.[78] The watercolor failed to fully illustrate the pearls, leaving out several adjacent to the handles (see fig. 7). Three of the pearls have visible drill holes and many have altered bezels, suggesting changes to these settings over time.

Handles

A pair of handles are mounted on either side of the upper border of the *Chalice*. This delicate metalwork was never intended for lifting the vessel and is a reminder that this object was primarily intended for display. Physical evidence and documentary evidence indicate that the handles have been significantly altered over time. Prior studies recognized that the vegetal curls now present inside the handles, although illustrated in the 1705 engraving, were not included in the 1633 watercolor (fig. 16; see figs. 7, 8).[79] Furthermore, the incised "acanthus" pattern along the sides of the handles is absent from the watercolor, where the handles have linear decoration resembling that still found on the *Sardonyx Ewer* (see fig. 13). Although it is possible the watercolor is simply inaccurate, another feature observed on the handles confirms that the originals were not simply changed, but replaced entirely. The handles now on the *Chalice* are decorated with single filigree rather than the double filigree found on its other mounts (fig. 17a).[80] The use of double filigree is a special decorative detail that emphasizes the exceptional quality of the metalwork commissioned by Suger. Its absence on the vessel's handles is highly improbable, particularly given that the handle and the body of the closely related *Sardonyx Ewer* are decorated uniformly with double filigree (fig. 17b). Further evidence of replacement is found along the upper edges of the handles, which were crudely notched to accommodate the lip of the vessel (see fig. 16). The method of attachment is also inconsistent with the original fine metalwork: the handles are fastened onto the upper border and knob using small lead tubes with flared ends.

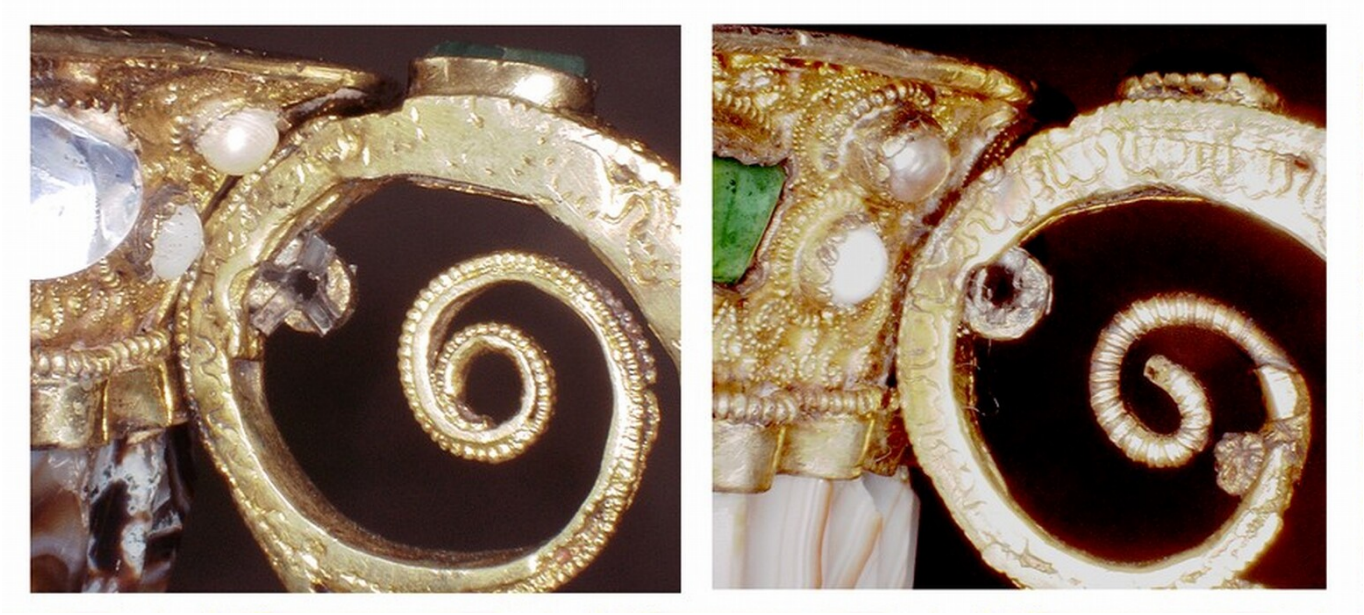

Fig. 16. Details of Suger Chalice (fig. 1). Left: back of right handle; right: front of left handle.

Fig. 17a. Detail of handle of Suger Chalice (fig. 1).

Fig. 17b. Detail of handle of Sardonyx Ewer (fig. 13).

The evidence offered by the engraving suggests the replacement of the handles occurred between 1633 and 1705. The handles must have been damaged significantly, such that they could not simply be repaired.[81] Instead of being newly fabricated, the handles now on the *Suger Chalice* appear reused, which is indicated by the presence of significant wear and extensive repairs, notably to the vegetal curls (see fig. 16). This supports replacement while the vessel was in the treasury, where similar objects with handles were available. The 1634 inventory included fifteen chalices and mentions objects in various states of repair as well as items that were broken or had gone missing.[82] The use of single filigree and the pattern of applied ornament suggest that the handles came from an object roughly contemporaneous with the *Chalice*, though of lesser quality. An early date is also supported by the gilded silver alloy of the handles, which is generally similar to the rest of the vessel, although the layer of gold is thicker than on the original parts.[83] The worn-down "acanthus" decoration along the sides of the replacement handles may yet offer clues to their date and origin.[84] The handles have the red toning layer, suggesting this was applied later in the vessel's history, a conclusion supported by the absence of this color on the *Eleanor Vase* and the *Sardonyx Ewer* (see figs. 12, 13).

The alteration of the handles raises the possibility that the form of the *Chalice* has changed over time. Some medieval chalices lacked handles, and the upper border and knob were joined by vertical metal bands; examples are the *Chalice of Urraca* from the Church of San Isidoro in León (Spain) and several of the Byzantine chalices at San Marco in Venice.[85] Other vessels combined handles and bands, including the now-lost rock crystal cup of Islamic manufacture, known as the *Chalice of Saint-Denis* (fig. 18), and the *Reliquary of St.*

Elizabeth, which was adapted from an earlier sardonyx chalice.[86] However, on the *Chalice of the Abbot Suger*, no evidence of bands was found on the surface of the sardonyx cup or along the edges of the upper border or knob. The position for each handle within the decoration of the upper border is bounded by a pair of pearls on either side, defining a space too narrow for a gemstone (see fig. 17a); a similar arrangement of pearls is found where the handle attaches near the rim of the *Sardonyx Ewer* (see fig. 17b). Thus, despite the extensive changes, the *Chalice* has always had a pair of handles. The only evidence that remains of their appearance is the 1633 watercolor, which suggests they were similar to the handle still present on the *Ewer* (see figs. 7, 13).

Fig. 18. Daniel Rabel, Watercolor of Chalice of Saint-Denis, 1633, watercolor, Cabinet des Estampes, Bibliothèque nationale de France, Paris.

Because the original handles on the *Chalice* were replaced, their decoration can only be understood from the seventeenth-century sources. The 1634 inventory lists two sapphires, two garnets, one chrysolite, two false emeralds, one amethyst, one glass paste replacing a missing stone, and nine pearls.[87] The gems recorded in the watercolor differ in both number and type. One handle has six settings—blue, red, green, purple, green, and red—with five white "pearls"; the other has four—green, purple, green, and red—with six "pearls." It is possible that some of these documented stones, pearls, and glass were reused on the replacement handles. The right

handle of the *Chalice* now has two garnets, a sapphire, a fragment of blue glass, and six pearls; the left has two beryls, a garnet, a small setting of red glass, and five pearls (see table 1).

Knob

Unlike its delicate handles, the *Chalice*'s knob provided a secure point to grasp and lift the vessel (fig. 19). The knob was critical to the structure of the vessel, as it served to connect the sardonyx cup to the stem and provided the lower attachment point for the handles. Its form—a slightly flattened sphere—resembles that found on similar medieval vessels, including the rock crystal *Chalice of Saint-Denis*, now known only from an illustration by Rabel (see fig. 18).[88]

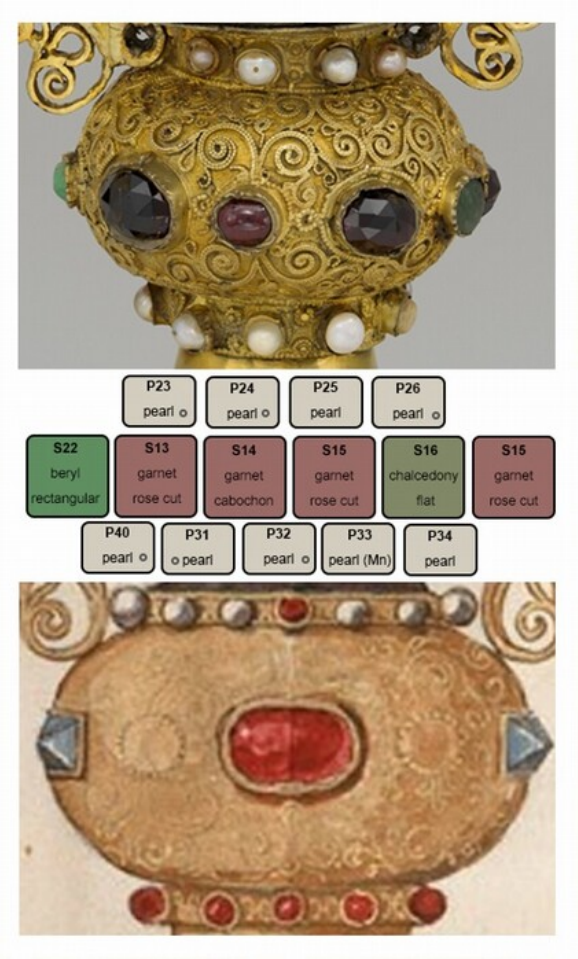

Fig. 19. Top: detail of knob on front of Suger Chalice (fig. 1); middle: identification of applied ornament (circles indicate drilled pearls); bottom: detail of Rabel, Watercolor of Suger's Chalice (fig. 7).

The filigree on the knob is generally well preserved, although some fine strands have been lost. However, significant detail has been lost on the rings above and below the knob, indicating extensive manipulation and reheating associated with changes or repair. Gaps between the rings and the center of the knob suggest that

the cup, knob, and stem may have been separated and reassembled over time (see fig. 19).[89] This would explain the slight misalignment of the decorative patterns on the upper border, knob, and foot. Despite this damage, these rings appear to be the original metalwork. Small circles of filigree in vertically stacked pairs alternate with the pearls, echoing the pattern of pearls and gemstones on the upper border. Like the flattened knob, this detail was shared with the *Chalice of Saint-Denis* (see fig. 18). In an apparent error, Rabel's 1633 watercolor of the *Suger Chalice* depicts the pairs of circles oriented horizontally rather than vertically. The knob and the rings have the red toning layer, suggesting it was applied after changes to the part of the vessel.

Ten larger stones encircle the center of the knob on the *Chalice*. Three are garnets that could be medieval, including two cabochons and one rectangular tablet. Five additional garnets have rose-type cuts, indicating a later, postmedieval date. The two remaining stones, a greenish chalcedony and a beryl, could be early; their placement on opposite sides beneath the handles suggests intention. The seventeenth-century inventory also listed ten settings, only two of which may correspond to those now present. A garnet, described as "broken into two pieces," could refer to the one on the vessel with a hairline crack, but even if it was recorded in 1634, its rose cut indicates it is not original (see table 1, S13). Two presines—green stones—were mentioned in 1634, one of which could be associated with the beryl below the left handle.[90]

Five of the inventoried stones are no longer present: a sapphire, an emerald, an onyx with an engraved bird, and two amethysts—one engraved with a man's head. The carved onyx and amethyst were likely ancient; one such stone remains on the base of the *Eleanor Vase*. The inventory also indicated two empty settings, one of the few written details that corresponds with the watercolor. The 1633 illustration (see fig. 7) includes a large red oval, presumably a garnet, on the center front of the knob, and the 1705 engraving also records a larger stone in this position (see fig. 8). The setting closest to this position on the *Chalice* now is smaller and circular, potentially an indication of further changes (see fig. 1). A peculiar detail in the watercolor is a pair of blue pyramidal stones on either side of the knob (see fig. 7); these do not correspond to the inventory or the object and suggest another detail invented by Rabel.

The ring above the knob of the *Chalice* has eight pearls, while the one at the bottom has nine pearls and one glass bead. This corresponds to the eighteen settings in the 1634 inventory, though those were all described as pearls. Many of the bezels have been altered, and the pearls have likely been reset, removed, or replaced. In the watercolor, the upper ring has seven settings on the front, rather than four, and the center one is red. The number of settings on the lower band is correct, but all are red, suggesting garnets, which is inconsistent with the inventory and the present condition of the vessel.

Upper Foot and Medallions

In the x-radiographs, the tapering top of the cone-shaped foot is seen to extend inside the knob (fig. 20). Based on this evidence, the investigators in 1974 suggested that the top had been inserted farther into the knob at a later date and that the *Chalice* had once been taller.[91] However, this is not supported by the 1633 watercolor or the 1705 engraving, where the relationship between the cup, knob, and foot appear similar to today. While some alterations have likely occurred, overlap between the knob and foot was critical to forming a strong mechanical connection. The earlier researchers noted that the medieval method of making chalices recorded by Theophilus did not include such an overlap.[92] However, the vessel described by that medieval author was made entirely from metal, unlike the *Chalice*, which incorporates a stone cup and requires a more complex

assembly. The presence of filigree would have also affected the design of the *Chalice*. While the stem and knob could be made as a single piece, fabricating these parts separately allowed the fine decoration to be applied to each individually.

Fig. 20. X-radiograph of Suger Chalice (fig. 1).

The upper sloping foot of the *Chalice* is generally well preserved, except for some small losses of filigree. This decoration defines five circular frames that now hold medallions with designs in low relief (fig. 21). Four have been consistently identified as later replacements—two with grapes alternating with two of wheat.[93] These medallions were cropped to fit within their frames and likely taken from another, much later object.[94] The seventeenth-century inventory and the watercolor recorded different medallions with embossed half-length figures. Further evidence of change is offered by the x-radiographs, where smaller circles are visible beneath these four medallions, presumably bezels that held earlier decoration surrounded by a reserved border (fig. 22).[95] Such an arrangement is also suggested by the 1705 engraving (see fig. 8), although the earlier watercolor confusingly shows the reliefs filling their frames. The older medallions may have resembled the decoration still found on the neck of the *Eleanor Vase*, where circular enamels are surrounded by a wide gilded border (see fig. 12). However, unlike those, the four hidden bezels on the *Chalice* are irregular in shape and size, suggesting reuse of ancient cameos or intaglios. Although the medallions appear golden in the watercolor, their material is not given in the 1634 inventory, where they are mentioned among the lists of gemstones.[96]

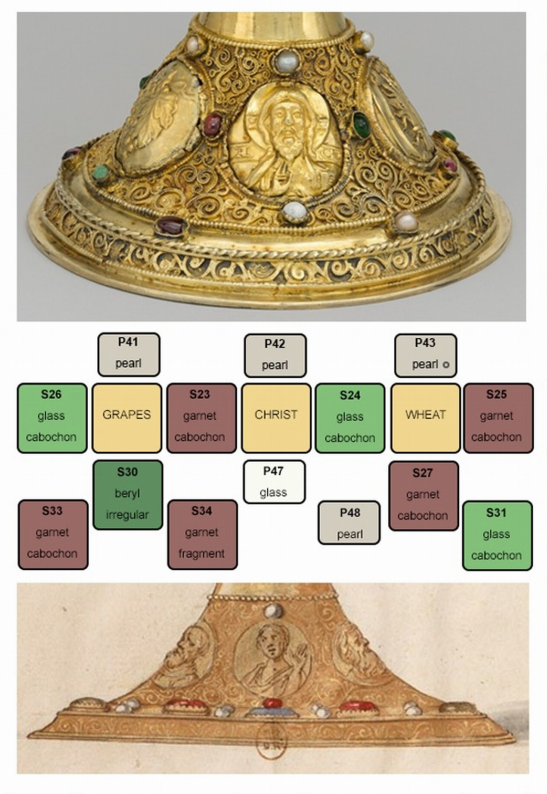

Fig. 21. Top: detail of foot on front of Suger Chalice (fig. 1); middle: identification of applied ornament; bottom: detail of Rabel, Watercolor of Suger's Chalice (fig. 7).

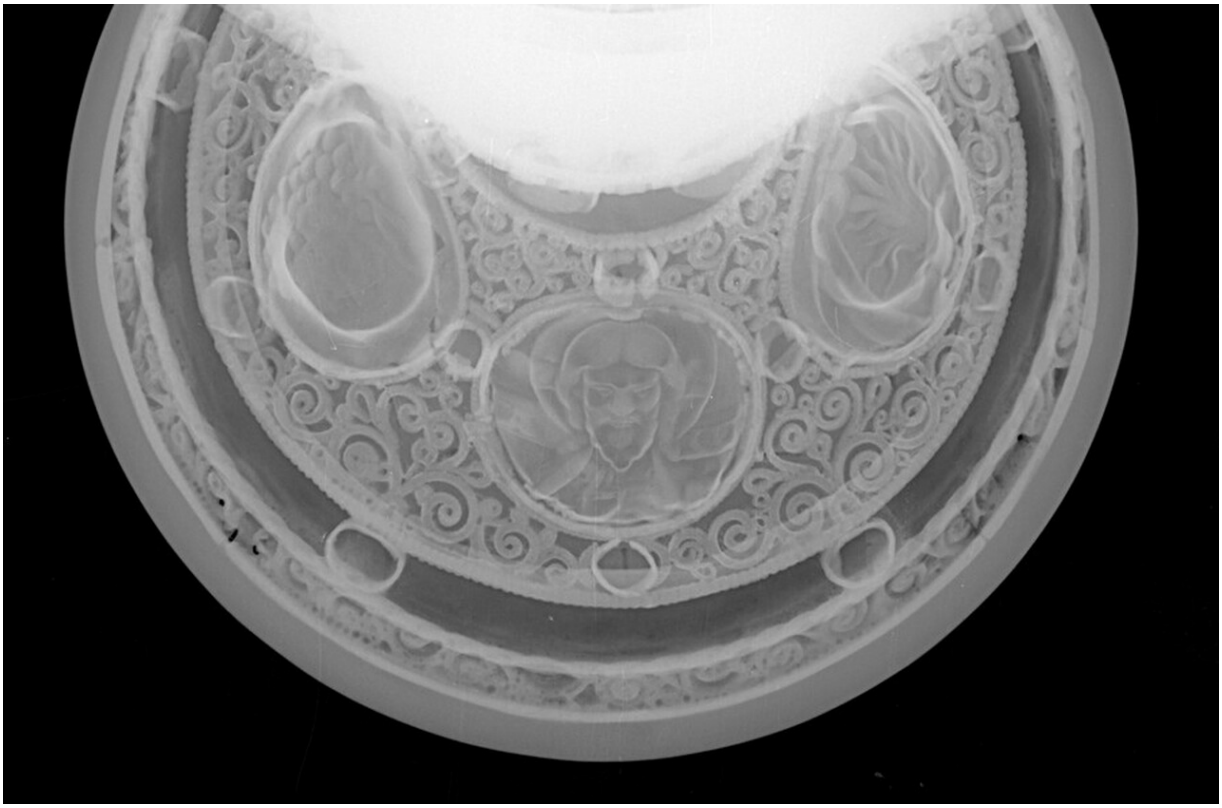

Fig. 22. X-radiograph of Suger Chalice (fig. 1), detail of medallions.

The central medallion that depicts Christ blessing has generally been accepted as original by previous authors (see figs. 1, 21). However, the bezel that secures the image is the same type found on the grape and wheat medallions, bezels certainly added when those reliefs were replaced.[97] In the x-ray, the thickness of the Christ medallion appears variable, suggesting it was cast rather than hammered like the other metalwork on the *Chalice* (see fig. 22).[98] The quality of execution is also inconsistent with the rest of the mounts; the figure lacks crisp details, and defects were left visible. The 1633 watercolor illustrates a different figure, which Verdier interpreted as a young Saint John the Evangelist or the Virgin Mary.[99] That interpretation assumed the medallion does not correspond to the bust of Christ but is on the back; however, the position of the relief, centered between the handles, is only possible on the front.[100] Given the extensive changes to the *Chalice*, the cup could have been rotated; however, the large red oval illustrated in the center of the upper border in the watercolor appears to correspond to the garnet now in that position on the front. The simplest explanation is that Rabel chose in his illustration to conflate the back of the sardonyx cup with the mounts from the other side, though significant changes to the metalwork cannot be ruled out.[101]

Whatever the front center relief once was, it presumably would have filled the frame, since no smaller bezel is visible in the x-ray.[102] If the other four were cameos or intaglios, the central medallion may have been a slightly larger ancient stone relief, repurposed for Christian use.[103] The prominent display of five antique cameos around the foot of the *Chalice* would have matched the exceptionally high-quality carving of the sardonyx and distinctive double filigree on the metalwork. This possibility is left open by the seventeenth-

century inventory, which did not identify the subjects of the medallions. The figures were only described as saints in 1804, recalling the appearance of the vessel after the theft.[104] The change most likely occurred during that event as Townley noted the wheat and grape medallions now present when he saw the vessel in 1804.[105] The thieves may have recognized the value of the antique cameos as independent objects and removed them but also realized that the vessel needed to look complete for sale.

Around each medallion on the *Chalice* are four smaller settings—above, on either side, and below—that are reserved in the filigree and original to the design (see fig. 21). The places above the medallions now hold four pearls and one white glass bead; between are two green glass beads, two garnets, and a pearl; and below are two garnets, a garnet flake, an irregularly shaped beryl, and a white glass bead. The inventory and watercolor present incomplete and conflicting evidence for these settings. The 1633 illustration includes only one white above and one red below––suggesting pearl and garnet––with none between. The inventory lists four peridots and an empty bezel on the top and six garnets below (although there are only five settings). If it is assumed that the row of pearls was accidentally omitted, then "peridots" might refer to green glass—although the inventory tends to identify gemstones correctly.[106] The garnets would then be associated with the bottom row, which still includes some of these stones and is also suggested by the watercolor.

Considering these different sources together, the arrangement around the medallions in the seventeenth century likely consisted of pearls at the top, green glass beads in between, and garnets at the bottom. Some of the pearls, as well as the four finished garnets and the two green glass beads, now present may date to that time. The six cabochons are of similar shape and size, suggesting they are related. To this group might be added a garnet and a green glass bead now set around the foot that could have been moved there as a result of later changes.

Lower Foot

The period sources offer convincing evidence of changes made to the lower foot of the *Chalice* beneath the register with the medallions.[107] In the 1633 watercolor (see fig. 7), this part of the foot appears broader and is decorated with large gemstones, generally resembling the arrangement found on the *Eleanor Vase* (see fig. 12). The foot is still preserved in the 1705 engraving, indicating this change was unrelated to the replacement of the handles (see fig. 8). It has been proposed that the damage to the foot occurred later in the eighteenth century, based on an inscription—"Suger Abbas"—described in 1737 but absent in 1791.[108] However, the inscription is first referred to in 1706, while those on the *Eleanor Vase* and the *Sardonyx Ewer* were specifically mentioned by Suger.[109] The original foot of the *Chalice* did not include a band that would accommodate an inscription, and the theft in 1804 seems the most likely moment for damage to the foot to have occurred. If so, the thieves may have had the vessel repaired prior to its sale, as Townley made no mention of damage in 1804.[110] However, the brother of Harry Harding, the dealer who acquired the *Chalice* in 1920, said that he had seen a photograph of the foot in a different state.[111] If this is true, the damage to the foot and subsequent repair would have occurred while in possession of the Townley family. Writing in 1921, Rosenberg felt that the repairs were executed in England; his manuscript includes a photograph in which the foot appears in its current state.[112]

Examination of the underside of the *Chalice* gives further insight into how the size of the foot was reduced (see figs. 6, 23). Starting below the original beaded wire border along the bottom of the register with the

medallions, the outer part of the foot was cut into three separate rings: the unornamented gilded band, the filigree border, and the flat rim at the bottom (fig. 23).[113] Small sections were cut from each ring to reduce its size, then the rings were reattached with each slightly overlapping the next. This approach allowed the repair to be carried out without introducing any new metal. To disguise the cut edge at the outside of the gilded band, a twisted wire border was added; although it is made of gilded silver, the underlying alloy contains slightly more lead and copper. Despite damage caused by extensive manipulation and reheating, the characteristic double filigree remains recognizable, confirming that this metalwork is original. The red toning is absent on this altered part of the foot, indicating that layer was applied before the changes occurred.

Fig. 23. Details of exterior and interior of foot of Suger Chalice (fig. 1). Indicated are the three cut rings—(a) unornamented gilded band, (b) band with double filigree, and (c) outer rim––as well as (d) original beaded border and (e) added twisted wire border. On the underside views, arrows indicate where small sections were cut from each ring.

The reduction of the foot of the *Chalice* necessitated the removal of the stones and pearls, leaving only the period sources to suggest its earlier appearance. The 1634 inventory listed twelve larger settings––three amethysts, two garnets, two sapphires, three presines, a topaz and an empty bezel. Their positions are suggested by the watercolor––blue at the center, red on either side, and outside that, green––although only five stones are illustrated. The inventory and watercolor indicate there were pairs of pearls between the larger stones, an arrangement much like that found on the upper border.[114] After the foot was altered, five small settings were added around the greatly reduced border (see fig. 21). These include a garnet and a green glass bead, mentioned above, that were probably moved from around the medallions. The remaining settings contain a garnet flake, a pearl, and a dark brown resin, presumably meant to suggest garnet. This rather haphazard combination suggests replacement with whatever materials happened to be available when the foot was repaired.

Conclusion

The new technical examination of the *Suger Chalice* has helped clarify its current state and, alongside reconsideration of the early sources that describe the vessel, understand what changes have occurred over its long history. The sardonyx cup began its journey nearly two thousand years ago when the raw stone, likely from India, was transported to Alexandria, where it was carved into a banqueting cup of exceptional quality. The ancient vessel remained well preserved until it reached France in the Middle Ages and became the centerpiece of a sacred object, encased in precious metal and gemstones. In the treasury of Saint-Denis further changes to the *Chalice* took place. Although a small number of white glass beads were introduced after the inventory of 1634, the number of gemstones increased, reinforcing the continuing significance of this vessel as a treasured religious object. The marked shift from amethysts to garnets may reflect a change in the availability of these gemstones or a change in preferences over time. The most significant change while at Saint-Denis was the replacement of the handles in the decades before 1705. Possibly at that same time, a layer of red toning was applied to the surface of the gold to help visually integrate the handles with the rest of the mounts.

More extensive changes to the *Chalice* occurred after it lost its sacred function, briefly moving into the national collections of France before it was stolen. Most likely as a result of the 1804 theft, the five medallions —which may have been ancient cameos—were replaced with more conventional religious symbols, muting the emphasis on the antique in the decorative program. Also during the theft, or perhaps later while in the possession of the Townley family, the foot was damaged and reduced, permanently altering its medieval profile. Many gemstones and pearls were also removed from the foot, some of which may have been reincorporated into the decoration of the *Chalice*.

The complex history of transformation presents a challenge to identifying the original appearance of the *Chalice*. The earlier handles likely resembled those on the closely related *Sardonyx Ewer*. The spaces now occupied by the medallions may once have held four smaller antique cameos surrounded by a gilded border and one larger stone at the center. The foot was once broader and had a decorated border, similar to that on the *Eleanor Vase*. On the original mounts—the upper border, knob, and stem—the preserved filigree establishes where gemstones and pearls were originally present. This new examination has eliminated ambiguity about the identification of the stones now present while recognizing that many were changed over the centuries. The 1634 inventory offers the most thorough description of the gemstones but does not specify location, and the results of this study found it to also contain some minor errors. The contemporary watercolor appears to offer compelling insights into the *Chalice*; however, close comparison with the physical evidence and the inventory found that the illustration contains numerous generalizations, omissions, and errors. While it is certain that the mounts of the *Chalice* once had a greater variety of stones, with more amethysts and fewer garnets, many details of the original decorative program ultimately remain speculative.

Deeper consideration of the materials of the *Chalice* initiated reflection on the global connections that existed in antiquity and the medieval period that could be pursued in future studies. Scholars are increasingly investigating questions of long-distance cross-cultural trade, even in the face of scant or absent written documentation.[115] The likely origin of the sardonyx cup, traveling from India to Alexandria, provides a glimpse of these early and extensive networks. In 1783, the cup was described as “trés belle agate orientale,”

suggesting the distant origins of the sardonyx were known.[116] At the time the metalwork was created, high-quality gold was being imported to medieval Europe from sub-Saharan Africa.[117] The numerous amethysts that once decorated the mounts were said to come from Germany.[118] The inventory also identified the pearls with Scotland and the "East"; the Gulf of Arabia was an important source in the medieval period.[119] The garnets may have been mined in India and Sri Lanka, and many of the other gemstones on the vessel may have similar distant origins.[120] As these historical networks come into focus, the *Suger Chalice* can be understood as a convergence of precious materials obtained through the artistic skill, technical knowledge, and physical labor of a global community.

Acknowledgments and References

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[1] Lecoy de la Marche 1857, 207–208; translation in Verdier 1990, 9.

[2] “Auri aut argenti ornamenta exponantur, aut in missa aut sicut eis placuerit.” Lecoy de la Marche 1867, 338. See also Brown 1988; Gasparri 1996–2001, 2:192–211. On the testament’s place within Suger’s writings, see Brown 2020.

[3] Doublet 1625, 361.

[4] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977; for the *Chalice* entry, 1:164–165.

[5] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164. Inglis 2016, 15–17, explains that the 1634 inventory drew on two earlier versions, a summary from 1505 and a complete inventory from 1534.

[6] Inglis 2016, 17.

[7] Inglis 2016, 1–17.

[8] For the original watercolor, Nicolas-Claude Fabri de Peiresc Collection, Paris, Bibliothèque nationale, Cabinet des Estampes, Aa53, fol. 92r. Reproduced in Guibert 1910, pl. III. See Van der Meulen 1997, 206–210, for gems, intaglios, and cameos from the treasury of Saint-Denis, witnessed by Peiresc, including the *Suger Chalice*, described in Appendix 3.9.1, and paten (now lost), in Appendix 3.9.4, that became associated with the chalice at a later date.

[9] Felibien 1706, 540, pl. III.

[10] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 3:no. XXI, 181.

[11] For an overview, see Verdier 1990.

[12] Charles Townley, diary entry of July 21, 1804, British Museum, Townley Archives microfilm, TY 1/20 in Hill index. Transcription by Emily Pegues, assistant curator, sculpture and decorative arts department, NGA. A special thanks to Emily for locating and transcribing this text.

[13] Du Mersan 1838, 178.

[14] Verdier 1990, citing an NGA curatorial file note by Douglas Lewis, “The Post-History of the Chalice of Abbot Suger,” May 15, 1979.

[15] Marc Rosenberg, “Woher?” (manuscript), 1921; later translated into English as Marc Rosenberg, “The Chalice of the Bishop Sugerius from St. Denis,” 1921–1930. Both were donated by Joseph Widener and are now in the holdings of the library at the National Gallery.

[16] Ricci 1923, although not illustrated; Braun 1932, pl. 3, fig. 8.

[17] Verdier 1993.

[18] A study patiently arranged by Parker Lesley, Curator of Decorative Arts, NGA. In attendance were Victor Covey, Chief of Conservation, NGA; Thomas Chase, Head of Conservation, Freer Gallery; and Arthur Beale, Object Conservator, Fogg Art Museum. Details documented in Parker Lesley, "Report on X-Ray of the Chalice of the Abbot Suger," object conservation department files, NGA, November 5, 1974.

[19] Lesley, in "Report on X-Ray of the Chalice of the Abbot Suger," stated, "The results of this experiment are extremely rewarding, and permission on the part of the National Gallery authorities can hardly be overpraised."

[20] Robert Brill, "Report on the Microscopic Examination of the Suger Chalice," object conservation department files, NGA, 1976.

[21] Pete Dunn, "Notes on Mineralogical Examination of Suger Chalice," object conservation department files, NGA, 1977.

[22] Verdier 1990, 15 n. 9, refers to Dunn, "Notes on Mineralogical Examination of Suger Chalice."

[23] Thanks to Kurt Heumiller and the imaging department at NGA.

[24] Exposures made at 280 kV, 2.0 Ma, for 180 seconds, with 0.01-inch Pb filter on tube, 0.005 inch Pb screen on front, 0.01-inch Pb screen on back, using Industrex XL Blue CR plates and scanned using a Carestream HPX-1 system. Contrast and sharpness adjusted for visualization using Adobe Photoshop.

[25] Qualitative XRF analysis was conducted with a Bruker Tracer 5 g Spectrometer equipped with a rhodium (Rh) anode tube and a silicon drift detector with a graphene window. All analyses were performed in an air path with the instrument positioned as close to the surface as possible but not in contact, using an 8 mm collimator. The factory-provided "GeoExploration" method performs a programmed sequence of three 30 second runs—15 kV, 10 μA with no filter; 30 kV, 11 μA with a titanium-aluminum filter, and 50 kV, 21 μA with a copper-titanium-aluminum filter.

[26] The factory-provided "Precious Metals" method performs a 30 second run at 40 kV, 11 μA with a titanium-aluminum filter.

[27] Qualitative XRF analysis was conducted using a Bruker M6 Jetstream Spectrometer equipped with a rhodium (Rh) anode x-ray tube, two 60 mm2 silicon drift detectors, and a helium (He) gas purge. Helium was used to analyze the pearls, the sardonyx cup, and the sardonyx inclusions; metalwork was analyzed in an air path. Point analysis was performed using the following run conditions: 50 kV x-ray tube voltage, 200 μA current, and 100 second accumulation time. The x-ray spot sizes ranged from 210 to 580 μm. Element mapping was performed using the aperture management system (AMS 500 or 1000), a 50 kV x-ray tube voltage, and a 600 μA current. The x-ray spot size used for each scan ranged from 100 to 210 μm, the acquisition time ranged from 10 to 30 ms/pixel, and the pixel size ranged from 50 to 100 μm.

[28] Spectra were collected on a Renishaw InVia Raman microscope using a 532 nm and 785 nm laser and CCD detector. The samples were examined with a 50× objective. The spectra were acquired in the range of 100 to 3200 cm^{-1} using an exposure time of 10 seconds, power of 0.1%, and 5 accumulations. The instrument was calibrated using the scatter peak for Si (520.5 cm^{-1}). For peak references for gemstones and pearls, see Hänni et al. 1998; Joyner, Freestone, and Robinson 2006; Bersani et al. 2009; Karampelas et al. 2012; Barone et al. 2015; Jehlička et al. 2016; Di Martino et al. 2019.

[29] Lecoy de la Marche 1867, 207–208; translation in Verdier 1990, 9. Dunn, "Notes on Mineralogical Examination of Suger Chalice," confirmed that the cup was stone and not ancient glass. Published in Verdier 1990, 25 n. 9.

[30] No clear association was found in point or mapping XRF between the distinct colored bands and the presence of trace elements.

[31] Götze, Möckel, and Pan 2020.

[32] Götze, Möckel, and Pan 2020.

[33] Götze, Möckel, and Pan 2020.

[34] Götze, Möckel, and Pan 2020.

[35] Within the inclusion, the elements are not distributed homogeneously but present in distinct phases.

[36] Lapatin 2015, 109.

[37] On the importing of precious stones from India and Sri Lanka, which expanded in the wake of conquests by Alexander the Great, see Lapatin 2015, 109–111. For more on ancient trade, see Thoresen 2017; Chandra 1977, 127. Further evidence of the Indian origin is presented in Habachi and Biers 1969, discussing a bowl at the Museum of Art and Archaeology at the University of Missouri, Columbia. The finest example, then in the Bog Farm Collection in England, is now at the J. Paul Getty Museum, 72.AI.38. Thanks to Rachel Patt for sharing her insights on hardstones in antiquity.

[38] For example, Indian deposits in Ratanpur, in use for more than two thousand years, come from a thin bed of conglomerate bound by a ferruginous cement. Bauer 1968, 517. A particular source may also be supported by the age of an agate, which may be estimated from the amount of structural water, which changes as moganite recrystallizes into chalcedony. For references, see Götze et al. 2020.

[39] Lapatin 2015, 150–151, 255. However, Gaborit-Chopin 1986, 286, calls it "probably Byzantine." Verdier 1990, 10, opines that "it is pointless to argue whether the gem acquired by Suger is Alexandrian or Byzantine" but leans toward the former based on comparative Egyptian works from the second century BCE. On the difficulty of dating sardonyx vessels and the likelihood that few are Byzantine, see Malgouyres forthcoming.

[40] J. Paul Getty Museum, 72.AI.38, https://www.getty.edu/art/collection/object/103SVE (https://www.getty.edu/art/collection/object/103SVE). For a contemporaneous ribbed glass bowl made to imitate banded agate (J. Paul Getty Museum, 72.AF.37), see Lapatin 2015, 111, fig. 23. The shallow ribbing of the c. 305–30 BCE breccia bowl from Alexandria in the Calouste Gulbenkian Museum, Lisbon, to which the *Chalice* is generally compared, is a far cry from the agate cup's fine fluting. For a recent photograph, see the Lisbon museum's online catalogue: https://gulbenkian.pt/museu/en/collection-of-stories/egypt/ (https://gulbenkian.pt/museu/en/collection-of-stories/egypt/).

[41] Lapatin 2021, 201–205.

[42] In reference to the *Chalice*, Suger uses the term "comparavimus" (we have acquired/procured/purchased). For his description, see Lecoy de la Marche 1857, 207–208; translation in Verdier 1990, 9. Gaborit-Chopin (1986, 286–289) makes a convincing argument that this refers only to the cup, not the vessel with its mounts. On medieval Paris, see the recent studies in Gajewski and McNeill 2023, esp. Grant 2023.

[43] Based on his recorded purchase and gift of the *Chalice* and the closely related mounts he commissioned for other objects. For discussion, see Verdier 1990, 13.

[44] Discussions with Genevra Kornbluth during a visit in 2023 to examine the *Chalice* helped clarify this interpretation.

[45] They discuss removal of the mounts from certain treasury objects in the course of measuring and molding the volumes of certain stone vessels. Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 2:178–180, docs. X–XIII.

[46] It has been suggested the foot was hidden by later modification of the mounts. Verdier 1990, 9.

[47] For further discussion, see Verdier 1990, 15–18. The significance of the double filigree was already noted in Rosenberg 1921, 10–12. Double filigree was presumed by Verdier (1993, 9) to indicate a connection with a Sicilian workshop by association with the double row of pearls stitched to the coronation mantle of Roger II of Sicily (d. 1154). However, Sicilian textiles do not consistently use double pearling. Besides the mantle, double pearling can be seen on a Sicilian alb but not its accompanying dalmatic and on liturgical

sandals but not their stockings, whereas the gloves that complete the set show both single and double pearling. See Andaloro 2006, 1:50–63.

[48] Gaborit-Chopin 1986; Gaborit-Chopin 1991; Gaborit-Chopin 2010.

[49] Although the date range has been given as 1137–1140 because of the presumed "portrait" of the *Eleanor Vase* on the west façade of Saint-Denis, consecrated in 1140, it is more likely that the Elders of the Apocalypse hold generic phials, as argued by Gaborit-Chopin 1986. Louis passed the vase to Suger apparently even before the royal couple separated in 1152. According to his *De Administratione*, the abbot had the venerable vase embellished and inscribed, then gave it to Saint-Denis. Beech 1993; Beech 2003; Panofsky 1946; Speer and Binding 2000.

[50] Translation in Inglis 2015, 225: "varios de cunctis regni partibus asciverat artifices, lathomos, lignarios, pictores, fabros ferrarios vel fusores, aurifices quoque ac gemmarios, singulos in arte sua peritissimos." Published in Gasparri 1996–2001, 2:327–329. Suger identified four groups of goldsmiths: "de diversis partibus, Lotharingi, Barbari, and nostrates." Gaborit-Chopin 1986, 284, 291.

[51] The group Suger designated as "ours" (*nostrates*). For discussion, see Gaborit-Chopin 1986, esp. 291.

[52] Montesquiou-Fezensac 1973–1977, 1:164. For conversion, see Verdier 1990, 22.

[53] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164.

[54] Quantification of the elemental content of the underlying silver alloy is challenging due to the presence of the gilding layer. Much of the variability observed resulted from variations in thickness of the gold caused by differences in the original application as well as subsequent wear. Gaborit-Chopin (1986, 293 n. 27) confusingly states that according to the NGA curator Douglas Lewis, recent analysis proved that the mounts were not gilded silver.

[55] The presence of a binder in this layer was not analyzed.

[56] Theophilus 1963, 115. For discussion of various historical methods of coloring gilding, see Pappot 2015, esp. 32.

[57] Christensen (1952, 6), followed by Wixom (1981, 108), incorrectly described the *Chalice* as decorated with rubies, emeralds, and jades. The ambiguous description in Verdier (1990, 20–21) is particularly misleading.

[58] Brill, "Report on the Microscopic Examination of the Suger Chalice"; Dunn, "Notes on Mineralogical Examination of Suger Chalice." Discrepancies from Dunn are only one glass bead identified as quartz and one garnet identified as a ruby. It is unclear why Verdier (1990, 1993) chose not to present these results.

[59] Bauer 1968, 2:345 ff. Other minerals that could be present include pyrope ($Mg_3Al_2Si_3O_{12}$), spessartine ($Mn_3Al_2Si_3O_{12}$), grossular ($Ca_3Al_2Si_3O_{12}$), and andradite ($Ca_3Fe_2Si_3O_{12}$). An experimental method (MIRAGEM) was used to distinguish mineral species with each spectra; preliminary results are reported in table 1. Bersani et al. 2009.

[60] Pion et al. 2020; Boschetti, Gratuze, and Schibille 2023; Bruni et al. 2021 suggested Sri Lanka or India as the source of garnets on a thirteenth-century cross in the treasury of Liège Cathedral.

[61] Bauer 1968, 2:306 ff.

[62] Bauer 1968, 2:282 ff., 504 ff.

[63] Karampelas et al. 2019.

[64] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165.

[65] An overview of the historic and modern practice of pearl drilling is given in Kunz and Stevenson 1908, 378 ff. Although not explicitly stated, stringing also would have eased transport of large numbers of small pearls.

[66] Theophilus 1963, 191–192.

[67] All correctly identified in Brill, "Report on the Microscopic Examination of the Suger Chalice"; Dunn, "Notes on Mineralogical Examination of Suger Chalice."

[68] The method used for XRF would not have detected sodium.

[69] Christensen (1952, 6), followed by Wixom (1981, 108), observed that original stones in the *Chalice* would not be cut in this way. For an overview of the rose cut, see Schmetzer 2020; Klein 2005, 156–158. For the introduction of faceted gemstones in Europe, see Klein 2005, 30–31. Theophilus (1968, 189–191) describes some basic techniques for cutting gems.

[70] Gaborit-Chopin 1986, 289.

[71] Theophilus 1963, 125.

[72] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165.

[73] This also seems to offer further evidence that the mounts illustrated are those on the front.

[74] The darker, more transparent stones on the *Sardonyx Ewer* (assuming these are original) are described in the inventory as "presine d'esmeraulde." Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:150 (no. 27). Verdier (1990, 21) fails to mention this "presine."

[75] Analysis of a thirteenth-century cross from Liège Cathedral found all the transparent green "stones," believed to be original, were glass. However, all but one contained lead, unlike those on the *Chalice*. Bruni et al. 2021. Analysis of the thirteenth-century Venetian *Chiaravalle Cross*, now at the Museo del Duomo in Florence, also found original yellow and clear glass but also apparently leaded. Di Martino et al. 2019. The medieval use of glass as ornaments, as well as their compositions, requires further study.

[76] The inventory identifies sapphires elsewhere and presumably would not have confused these with glass.

[77] On the various functions of treasuries, see the studies by Cynthia Hahn, especially Hahn 2010; Hahn 2011.

[78] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165.

[79] Verdier 1990, 17–18. Engraving in Félibien 1706, 540, pl. III.

[80] Verdier (1990, 15) may have noted this as he did not include the handles among his list of parts of the *Chalice* decorated with double filigree, but he did not explicitly state the distinction.

[81] Such an event occurred with the *Sardonyx Ewer*, the foot of which was replaced in the fifteenth or sixteenth century. Wixom 1981, 112–113.

[82] Inglis 2016, 25. Suger recounts that the vase to which he added the eagle mounts "had lain idly in a chest for many years." Panofsky 1946, 78–79; Speer and Binding 2000, 368–369.

[83] In the spectra from spots analyzed on the handles, the gold peak was consistently larger than found on the upper border, knob and foot. For challenges of analysis, see note 54.

[84] The acanthus pattern is quite variable introducing some doubt as to its date and attribution. Verdier (1990, 18, 24, notes 61, 97) noted acanthus handles on a sardonyx chalice transformed into the reliquary of Saint Elizabeth (41345_HST) in the Swedish History Museum, Stockholm, and a rock crystal chalice in the San Marco Treasury (British Museum 1984, 299, fig. 43j). However, neither is a close comparison, having raised or carved rather than engraved designs.

[85] Martin 2020, 44, fig. 2.5; British Museum 1984, 136 ff., cat. nos. 11, 16, 17.

[86] Schramm and Mütherich 1962, 193.

[87] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165.

[88] This vessel was also stolen in 1804 but never recovered. Watercolor reproduced in Guibert 1910, pl. VI; also illustrated in Félibien 1706, 540, pl. III. For the 1634 inventory, see Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:161.

[89] A possibility raised in letters of 1633; see discussion in note 45. Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 2:178–180, docs. X–XIII.

[90] For *presine*, see discussion above for a stone in the upper border.

[91] Lesley, "Report on X-Ray of the Chalice of the Abbot Suger."

[92] Theophilus 1963, 99–103.

[93] Rosenberg 1921, 24; Christensen 1952, 6; Wixom 1981, 108; Verdier 1990, 19–20.

[94] Kornbluth suggested that these could be spolia cut from an eighteen-century object, possibly another chalice based on the imagery. Genevra Kornbluth, "Christ Human and Divine in the Chalice of Abbot Suger," draft March 23, 2001, object conservation department files. Cited by permission of the author.

[95] Although observed in the x-rays made in 1974, this evidence fails to be reported in Verdier 1990 but was discussed in Kornbluth 2001, 4–5.

[96] Kornbluth (2001, 6) also noted the discrepancy between their appearance in this image and the inventory description.

[97] Rearrangement of the filigree had been proposed during the 1974 examination; however, this would be impossible without significant damage to the fine decoration.

[98] Wixom 1981, 108. Verdier 1990, 19–20, uses the terms "embossed" and "stamped." Kornbluth, 2001, 3–4, noted the variable thickness of this relief and proposed that it was cast.

[99] Verdier 1990, 20.

[100] The view of the back has been noted by previous scholars.

[101] The removal and reattachment of mounts from certain treasury objects seems to have occurred. Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 2:178–180, docs. X–XIII.

[102] Wixom 1981, 108; Verdier 1990, 19–20.

[103] Examples of antique images repurposed as Christ are a cameo of Augustus at the center of the *Lotharkreuz* (Aachen, Domschatzkammer), https://www.aachener-domschatz.de/lotharkreuz/ (https://www.aachener-domschatz.de/lotharkreuz/); a lapis lazuli female head on the *Herimann-Idakreuz* (Kolumba-Kunstmuseum des Erzbistums Köln); and a chalcedony head of Bacchus on the *Lebuinus Gospels* (Museum Catherijneconvent, Utrecht),

https://adlib.catharijneconvent.nl/Details/collect/61050 (https://adlib.catharijneconvent.nl/Details/collect/61050). Fachechi 2011, 173–176; Kinney 2011. See also the multiple reused stones on the foot of the sardonyx chalice repurposed as a reliquary for Saint Elizabeth (41345_HST), Swedish History Museum, Stockholm. Schramm and Mütherich 1962.

[104] Wixom 1981, 108; Verdier 1990, 20; Inglis 2006, 17.

[105] Townley 1804. For photograph, see Rosenberg 1921.

[106] Peridots are not mentioned in the inventory descriptions on either the *Eleanor of Aquitaine Vase* or the *Sardonyx Ewer*. Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:150 (no. 27), 166 (no. 75).

[107] Verdier 1990, 22–23.

[108] Wixom 1981, 108–110. For the documents, see Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 2:180–181.

[109] Lecoy de la Marche 1867, 207–208.

[110] Townley 1804.

[111] Verdier 1990, 22 n. 8.

[112] Rosenberg 1921.

[113] Verdier 1990, 23, suggested that the beaded string at the base of the stem was also added.

[114] The inventory lists twenty-seven pearls, including two that were empty, although the arrangement described should have twenty-four.

[115] Guérin 2013; Hamilton and Proctor-Tiffany 2019; Nol 2021; Flood and Fricke 2023.

[116] Montesquiou-Fezensac and Gaborit-Chopin, 1973–1977, 2:181.

[117] Gold began crossing the Sahara in the eighth century, with trade increasing in the tenth century and continuing to grow in subsequent centuries. Spufford 1988, 163 ff. Hoards of Almoravid coins struck prior to 1147 have been found in various locations in France. Messier 2019, esp. 209. Writing in the early twelfth century, Theophilus (1963, 118–120) also suggests extensive trade of gold, mentioning four sources: the land of Havilah, Arabian, Spanish, and the banks of the Rhine. The first three could ultimately derive from West African sources.

[118] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165.

[119] Montesquiou-Fezensac and Gaborit-Chopin 1973–1977, 1:164–165. For an overview of pearls from the Gulf, see Carter 2005; Kunz and Stevenson 1908, 85 ff. Theophilus (1963, 191) states only that they come from shells in seas and rivers.

[120] The sapphires on the thirteenth-century Venetian *Chiaravalle Cross*, now at the Museo del Duomo in Florence, appear to have come from Myanmar or Sri Lanka. Di Martino et al. 2019.

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