NEW AGE OLD MASTERS

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ABSTRACT
The paper considers the contribution that the history of science can make to conservation science and technical art history. In particular, it uses scientific texts from the thirteenth and fourteenth centuries to interpret the significance of materials on the *Westminster Retable*, *c*.1260. This prestigious altarpiece was decorated with imitation gems, and the paper explores the intellectual context in which it was conceived and created.

ZUSAMMENFASSUNG
Im vorliegenden Beitrag wird darüber nachgedacht, welchen Beitrag Wissenschaftsgeschichte zur Konservierungswissenschaft und Kunsttechnologie leisten kann. Dabei werden wissenschaftliche Texte des dreizehnten und vierzehnten Jahrhundert zur Interpretation der Bedeutung der Materialien des Westminster Retabel (*c*.1260) herangezogen. Dieser repräsentative Altar wurde mit Edelsteinen-Imitationen dekoriert, und der Beitrag geht der Frage nach, in welchem intellektuellen Kontext er geplant und geschaffen worden ist.

INTRODUCTION

This paper considers the role of science in contributing to our understanding of the context in which an object was conceived and created. It does so by looking at the significance of some materials in a mid-thirteenth-century altarpiece, the *Westminster Retable*, Fig. 1.

The *Westminster Retable* contains some of the most exquisite painting in the history of western European art, Fig. 2. The context in which it was conceived and created was pan-European. Its original appearance would have been reminiscent of German reliquaries and it still shows French and Spanish influences. It was created in or around 1260 as part of Henry III's programme of building at Westminster and is generally supposed to have decorated the high altar in front of the shrine of St Edward the Confessor.

One of the roles of conservation science is to provide material facts that inform art historical suppositions. Some of these material facts may be quite accessible, whilst others can be more obscure and require specialist examination. Recent technical examination of the retable at the Hamilton Kerr Institute has generated material facts that have informed scholars' suppositions about its specific and general contexts.

Fig. 1 The *Westminster Retable*. *The Dean and Chapter, Westminster Abbey*.

Fig. 2 Detail, The Feeding of the Five Thousand. *The Dean and Chapter, Westminster Abbey*.

For example, the retable's width and height (333 by 94 cm) correspond to the dimensions of a recess in a screen behind the high altar and elemental analysis of its glass suggests an origin in France [1, p. 68]. Yet material facts derived from simple or complex measurements are no less ambiguous than other phenomena that inform art historical suppositions. For example, the retable's dimensions were altered and the screen with the (current) retable-sized recess is a later construction, raising questions about possible changes in the retable's location [2]. The identity of the glass may, in itself, be relatively unambiguous but its mere presence raises questions about the object's status and function.

Modern science provides tools that enable technical comparisons to be made between works of art. For example, quantitative energy-dispersive X-ray (EDX) analysis generates a body of data that enables hypotheses to be advanced about glass-making. These can be interpreted in terms of the sourcing of raw materials and the distribution of particular methods of manufacture. Modern science may inform questions about how glass was made, but its ability to contribute to questions about why the *Westminster Retable* contains glass is limited. This question has a significant bearing on our understanding of the object. It is a material aspect that informs the way in which the object was conceived; the glass is in a number of guises — as false gems, cameos, enamels and ceramics. Its presence raises the question: why should some of the most exquisite painting in western European art, in the most prestigious position in England, be surrounded by imitations?

One possibility is that Henry III ran out of money. Detailed accounts of work at Westminster survive and give some idea about the costs of the Abbey's fabric and furniture [3]. The retable is not identified in these accounts, but costs associated with the high altar's frontal are recorded. The frontal (which no longer survives) contained real gems and cost about £250. The retable contained false gems and probably cost around £50 [4]. Differences between the frontal and retable are beyond the scope of this paper, but both can be put in context with the building works. Total expenditure on the Abbey over 32 weeks in 1253 (a period with particularly complete accounts) was £1,651.19s.0d [5]. Annual expenditure was therefore about £2,684. Construction activity fluctuated, but the frontal represents nearly 10%, and the retable nearly 2%, of total annual expenditure on the Abbey at the height of its remodelling in the mid-thirteenth century.

The five-fold difference in price between frontal and retable suggests the difference between real or false gems was significant, but we know that Henry III was willing to raise credit for works of art if necessary [6], and it would seem strange to cut costs on one of the most liturgically important items in the Abbey. So, cost may not have been the major issue in choosing materials for the retable. The presence of real and false gems, etc., raises questions about the comparative status of mid-thirteenth-century English frontals and retables. However, it also raises wider issues about the perceived value of artists' materials, the objects of study in conservation science and technical art history.

CONSERVATION SCIENCE AND TECHNICAL ART HISTORY

Conservation science and technical art history focus on the exact identity of artists' materials, because exactitude facilitates discrimination. Interest in discriminating between materials is two-fold. Firstly, differentiation provides clues about sources or preparations — for example, with lead isotope ratios or media azelate contents. Secondly, it provides insights into behaviours — for example, between fast or fugitive pigments.

Whilst conservation science studies artists' materials, it tends not to look at them in the same way as artists did. For example, correlations, like isotope ratios, may exist between pigments and geological sources, but artists were not aware of such correlations and they might not have considered the location of sources particularly relevant. The Westminster accounts suggest iron from Gloucestershire was considered superior to iron from other sources [7]. However, there are no comparable statements about lead, and its origins in Derbyshire or the Mendips are not specified [8, 9] Similarly, artists would have been unaware of the potential azelate content of their medium [10]. They prepared media to modify handling, drying and optical properties. If they had any interest in long-term paint behaviour, it was not expressed in molecular terms. Conservation science measures differences between materials, but the differences upon which it focuses are those that are amenable to analysis, not necessarily those recognized or valued by the artists. Almost fortuitously, material differences provide insights into trading patterns or working practices by identifying trends across bodies of comparable objects.

In considering how science contributes to our understanding of the context in which an object was conceived and created, the *Westminster Retable* is interesting because of the paucity of comparable objects. Most comparisons have been made with objects that are geographically, chronologically, or technically different. Yet conservation science provides data and the challenge for technical art history is to find contexts in which those data can be interpreted with confidence.

The possibility that financial constraints might account for the use of glass is open to question. Alternative reasons for the presence of false gems, etc., in a prestigious object may therefore be sought. False gems have lower monetary value than real gems, but the values associated with a high altar are not only economic. There will have been several different value systems in play, some of which might not be obvious to us. Values — other than monetary — that may have influenced the creation of the retable include those informed by scientific beliefs. Conservation science acknowledges the history of art's relevance. However, to date, the same recognition has not been afforded to the history of science. Technical art history requires input from a history of *techne* (craftsmanship).

THIRTEENTH-CENTURY SCIENCE

The modern science that guides the technical examination of cultural objects is a positivist value system. It is independent of, and theoretically neutral towards, religious beliefs. But thirteenth-century science was not positivist and was not independent of religious beliefs. Medieval scientific texts are widely recognised to have been 'aids for meditation' [11]. Christian beliefs obviously determined the iconography of the retable. Through non-positivist science, they may also have influenced material aspects of its creation [12]. The rise of nominalism, from which emerged the empirical and eventually positivist science that we recognise today, did not occur until after the retable's creation [13].

The science that guided artists, or that they used to post-rationalize their technical observations, was shaped by Christian, Platonic and Aristotelian principles, and is identifiable in artists' treatises [14]. A full examination is beyond the scope of this paper, but we can restrict our enquiry to beliefs about stones as described in lapidaries. These were popular (dwelling on magical properties), symbolic (restricted to stones in the Bible) or scientific [15, pp. 51–94]. The retable's creation coincided with a definitive scientific lapidary by a German Dominican, Albertus Magnus [16, p. xli; 17]. His text, which summarized a survey of personal observations of crafts, was not innovative, but followed a long-established tradition [18]. Its importance lay in formally presenting knowledge that was circulating in more obscure cultural guises.

Albertus' lapidary provides an insight into the mid-thirteenth-century understanding of materials and helps us reconstruct some of the scientific context in which the *Westminster Retable* was conceived and created. This, in turn, informs the question about imitation materials in a prestigious object. Several different colours of glass were used on the retable, each in several contexts. This paper looks at the use of blue glass and the material it imitated — lapis lazuli.

LAPIS LAZULI

Lapis lazuli — also known as sapphire — was described as the colour of the night sky, with white (calcite) streaks like 'clouds' [16, p. 115]. It also had gold (pyrites) 'stars', accompanying the clouds [19]. Analysis of Cennini's recipe for preparing ultramarine from lapis lazuli indicates that the blue component was, in Aristotelian terms, predominantly elemental water [20].

Lapis lazuli was mentioned in popular literature as a medicine [21]. In the scientific literature, the painter's and physician's use of ultramarine are closely connected. For example, Albertus records ultramarine's use as a pigment and as a drug in adjacent sentences, claiming it "cools internal heat, checks sweating and cures headache" [16, p. 125]. It was a commonplace remedy for fever [22]. Dioscorides suggested it as an antidote to snake bites [23]. Albertus also recommended that the whole stone is "put into the eye to remove dirt" [16, p. 115]. Pope John XXI said it healed diseases of the eye [24]. Rings containing sapphire/lapis lazuli were left in churches for that purpose [25] and the inventory of Charles V records an "oval oriental sapphire for touching the eyes" [26].

Lapis lazuli's properties were also psychological. It generated peace, harmony and accord and encouraged piety and devotion to God [27; 16, p. 115]. It was hallowed to Apollo, and "maketh a man meek and mild and godly" [28]. It promoted foresight, protected from witchcraft, and was used in hydromancy [29, 27]. It also helped prayers come true — it "draws responses from the realms above" and was "vigorously honoured by God" [15, pp. 212–213].

Lapis lazuli's properties were comprehensively described by Marbode, including some that are only explicable if it was considered as a synonym for some cosmic force associated with elemental or hylomorphic water. For example,

> The captive's chains its mighty virtue breaks;
> The gates fly open, fetters fall away,
> And sends their prisoner to the light of day [30].

It is unlikely that lapis lazuli was ever considered a practical tool for freeing prisoners. Some properties required the stone to be touched or the powder to be ingested, others only required it to be seen. The reflected blue light recalled the bliss of heaven and gave hope [31, 29].

In addition to these potential uses, lapis lazuli was actually used in paint on the retable. In the context in which the retable was conceived and created, ultramarine evidently provided more than just colour. It had spiritual, psychological and physiological effects on viewers. These non-aesthetic properties may help account for ultramarine's price. The accounts show that 'azure' was very costly [32]. Indeed, Henry III specifically prohibited its use in less prestigious commissions [33]. The retable's paint therefore incorporates the most expensive pigment available. This is in sharp contrast to the decorative use of glass imitations.

GLASS

Theophilus made glass from beechwood ash and sand [34, pp. 52–53]. Albertus said that the process "depends upon alchemy" and Vincent of Beauvais considered it "one of the two things in which lies all the secret of the art" of alchemy [16, p. 15; 35]. The process was widely known, in theory, if not in practice, and was such a graphic example of transformation that it was employed in popular literature. For example, referring to fern as opposed to beechwood ashes, it was observed that

> Neither is the glass fern, nor does the fern remain glass [36].

Theophilus also described how to make transparent blue glass for windows using opaque glass "like little square stones" from ancient mosaics [34, p. 59]. Using different colourants, the *Mappae clavicula* gives a recipe for a stained-glass called sapphire [37]. These ingredients and names suggest that blue glass and blue stones were not unconnected.

A thirteenth-century encyclopaedia states that the most precious colours are those most full of light [38, p. 47]. Real lapis lazuli is opaque, so not full of light. Transparent blue glass, on the other hand, is full of light — a property that gave it value. For example, in the fourteenth century, light from the blue windows of Sainte-Chapelle, Paris, was described as contributing to its mystical rapture [1, p. 65].

Influenced by Sainte-Chapelle, Westminster Abbey also had coloured windows. Coloured glass was 12s per seam, corresponding to 3d per square foot of window [39][1]. By contrast, the same series of accounts show 2lb 3oz of azure cost 32s 1d, or 11d per ounce (88 times the price of lead white) [40] and azure could cost up to 20d per ounce [41]. One ounce of ultramarine therefore cost the same as between 10lb and 17½lb of blue glass, sufficient for between four and seven square feet of window.

There was a significant difference in the cost of lapis lazuli and blue glass. Another distinction is that one is natural whereas the other is artificial. However, artificial materials were not necessarily inferior. The medieval aesthetic valued workmanship as well as materials. The purification of lapis lazuli was skilful, but it was not equal to the conversion of sand and ashes into sapphire. As well as being full of light, blue glass embodied workmanship in a way the stone did not.

MATERIALS AND WORKMANSHIP

In his commentary on St-Denis, Paris, Abbot Suger was proud that the "workmanship surpasses the material" [42]. Workmanship was commonly called 'art' — a term encompassing any activity involved in artifice or the artificial. The value of workmanship or art was explicitly stated on a twelfth century altar cross. Its inscription states:

> Art is above gold and gems: the Creator is above all things . . . [38, p. 50].

Art's status is a key to understanding why the retable contained imitation rather than real gems.

In the thirteenth century, Thomas Aquinas said "art imitates nature in her manner of operation" as opposed, or in addition, to imitating her appearance [43]. This way of understanding imitative art was repeated almost verbatim in alchemical texts [44, p. 194]. Today, the study of nature's operation is 'science' and its practical application is 'technology', which, in the fourteenth century, Paul of Taranto divided into two types — sometimes restricted to:

> an accidental extrinsic form, as in the art of painting [or] sculpture . . . and sometimes . . . restricted to a substantial intrinsic form, as in agriculture or medicine . . . [45].

He distinguished between the two by considering what was manipulated — qualities such as colour and shape, or the 'four principle qualities' of hot, cold, wet and dry. Combinations of these qualities underlay the four elements — earth, water, air and fire — of which the whole world was made. These elements were not building-blocks like modern elements, they were modes of existence — solid, liquid, gaseous and consuming, respectively [20]. The arts that manipulated these 'four principle qualities' — like agriculture and medicine — imitated nature 'in her manner of operation,' as did alchemy, considered to be 'the best imitator of nature' [16, p. 158].

Glass-making, which was deemed alchemical, was used to demonstrate the way in which arts in general operated. For example, Richardus Anglicus said:

> art is nothing but an aid to nature . . . [if] glass were not hidden in the cinders, art would by no means be able to make glass from [cinders] [46].

This introduces an important point about the presence of imitation materials on the retable. Art could 'imitate nature in her manner of operation' and was an 'aid to nature'. Artists therefore facilitated natural processes and alchemists claimed to assist natural processes "when all necessary conditions already pre-exist" [44, p. 163]. The imitation of nature was a legitimate activity, the products of which were artificial, but not necessarily unnatural. In the middle ages, 'natural' and 'artificial' were not necessarily mutually exclusive. Plotinus said:

> . . . if anyone despises the arts because they produce their works by imitating nature, we must tell him, first, that natural things are imitations too. Then he must know that the arts do not simply imitate what they see but they run back up to the forming principles from which nature derives . . . [47].

Recalling Paul of Taranto's definitions, the arts that 'simply imitate what they see' include naturalistic painting and sculpture. The arts that 'run back up to the forming principles' are like agriculture, medicine or glass-making. Albertus identified the 'forming principles' that nature imitated. He said:

> all things whatsoever, whether made by nature or by art, receive their impulse in the first place from the powers of heaven. In nature there is no doubt of this. But even in art it is recognised, because some [impulse] . . . incites the heart of the man to make [something]. And this can only be the power of heaven . . . [16, pp. 134–135].

So, whether natural lapis lazuli or artificial blue glass, the 'forming principle' can be the same. It is 'the power of heaven'. If the 'impulse' of the artist was to imitate lapis lazuli, then the stone's well-documented properties may have been shared by blue glass.

PRODUCTION AND RECEPTION

Blue glass was used in three contexts in the retable: as small gems, large crosses and as medium-sized octagons, Fig. 3. The small gems were generally oval. The large crosses were decorated with mordant gilded foliate patterns, and the medium-sized

[1] In pre-decimal English coinage there were 12 pence (d) per shilling (s), and 20 shillings per pound (l or £). A seam was a measurement of volume, corresponding to 8 bushels, or 291 litres. A square foot was equivalent to 900 cm^2. There were usually 12 ounces (oz) to a pound (lb), corresponding to troy weight, but 16 ounces avoirdupois, and the pound could also vary locally. One troy pound is 373 grams; one avoirdupois pound is 454 grams.

Fig. 3 Surviving blue glass, in imitation of lapis lazuli. *The Dean and Chapter, Westminster Abbey.*

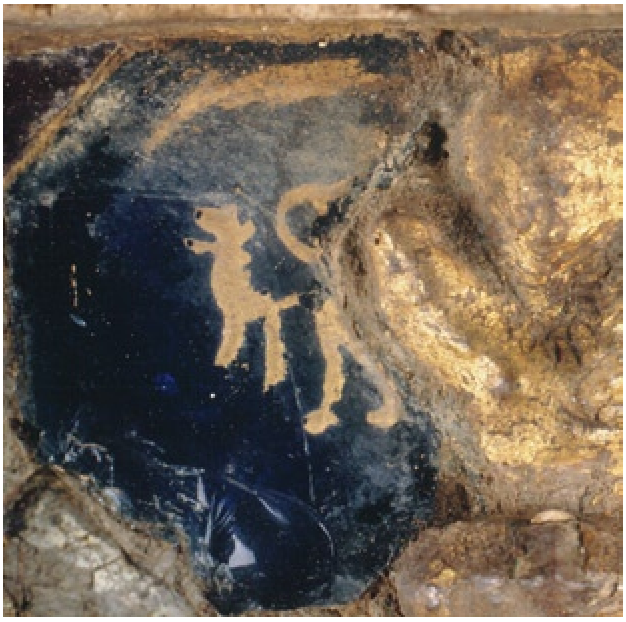

Fig. 4 Medium-sized octagonal glass with gilded lion. *The Dean and Chapter, Westminster Abbey.*

octagons with gilded lions, Fig. 4. The small gems could be reminiscent of the 'oval oriental sapphires' used to treat diseases of the eye. The overall shape, colours and decorative patterns of the large crosses are strongly reminiscent of Persian *lajvadina*-ware (ceramic imitation lapis lazuli). The use of blue glass on the retable could therefore be considered to imitate lapis lazuli.

Contemporary science recognised that lapis lazuli and blue glass imitations were made by different agents — naturally by geological processes and artificially by skilled craftsmen — but they were both products of the same 'power of heaven'. Lapis lazuli and blue glass were different in substance, but the same in essence. Their substantial difference was reflected in the more than one hundredfold difference in cost. Their essential similarity may be reflected in the fact that imitations were acceptable in a prestigious object.

Technical examination suggests that the false enamels and ceramics were not mass-produced, and it is probable that the false gems and cameos were also made individually. These imitative decorations were specifically intended for the retable and it is reasonable to assume that, when created, they were not intended for circulation. The monetary value of blue glass might therefore have been considered less significant than the other values it shared with lapis lazuli by virtue of their common 'forming principle'.

Modern science does not recognize those values but thirteenth-century science provides many texts suggesting they may have been recognized by Henry III and the Westminster craftsmen. No documentation exists to confirm that supposition, but the retable itself provides evidence that suggests people placed value in the imitation decorations.

Technical examination indicates that the retable's current condition is mainly due to theft. Of more than 2000 false gems, less than 20 survive, and of 36 false cameos, only one survives. The rate of loss of individual components may have been affected by accessibility and ease of extraction, but in the centre, blue glass octagons are found in conjunction with similarly-sized red glass lozenges. Here, the rate of loss of the two types of glass is not equal. Statistical analysis shows that the blue-glass octagons have been stolen preferentially [48], Fig. 5.

These glass octagons could be conceived as imitation sigils — stones containing an image. Commenting on sigils, Albertus said:

> The Ram or the Lion or the Archer . . . indicate that these stones . . . make their wearers skilful and clever, and . . . raise them to positions of honour in the world; the Lion especially [16, pp. 140–141].

Imitations of such stones were evidently appropriate decoration for the high altar of Westminster Abbey, but Albertus was writing as the retable was being created, not as it was being dismantled — the false gems, cameos, sigils, etc. were stolen between the sixteenth and eighteenth centuries [49]. However, numerous seventeenth-century texts show that such values endured. Frobisher had ultramarine in his ship's medicine cabinet [50] and Burton claimed it "frees the mind and mends manners" [51]. Even the self-styled sceptical chemist, Robert Boyle, said:

> I will not indiscriminately reject all the Medicinal Virtues that Tradition and the Writers about precious stones have ascribed to those Noble Minerals [52].

It follows that blue glass octagons with gilded lions may have been stolen because they were thought to make people 'skilful and clever' and raise them to 'positions of honour in the world'.

Fig. 5 Detail, deliberately removed glass tesserae. *The Dean and Chapter, Westminster Abbey.*

CONCLUSION

Modern science identifies artists' materials on, and patterns of loss from, the *Westminster Retable*, but in the details examined here, it is the history of science that assigns significance to modern science's discoveries. Together, they throw light upon the context in which the retable was conceived and created, as well as illuminating how it was treated in the following centuries. They provide evidence of enduring cross-boundary cultural values associated with artists' materials. Such evidence suggests that the secure interpretation of data in technical art history requires the acknowledgement of a wide variety of cultural issues. It also shows that ideas currently in circulation, such as heavenly powers channelled through both crystals and skilled practitioners, are anything but new.

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