A Golden Landscape in an Ultramarine Sea

Research into the 'Spanish Map' of 1552-53

• JOOSJE VAN BENNEKOM AND DIRK JAN BIEMOND •

One of the highlights of the Rijksmuseum is what is known as the 'Spanish Map', a map of the Iberian Peninsula in the reverse glass painting technique, mounted in a silver-gilt frame. While the object was being restored and conserved for permanent display in the renovated Rijksmuseum, a great many new art-historical and technical facts came to light. In this article, Dirk Jan Biemond discusses the art-historical questions surrounding the piece, while Joosje van Bennekom reports on the discovery of possible nineteenth-century additions to the inner support of the frame. In the article that follows this, Simone Bretz writes about the conservation of the reverse painted 'Spanish Map'.[1]

A Costly Object for a Kunstkammer

In the mid-sixteenth century the most distinguished European courts assembled collections in special rooms or 'cabinets' known as *Kunstkammer*, where they aspired to reproduce the universe in miniature in the most precious materials. Objects from the natural world were juxtaposed with works of art in gold and silver or made of glittering gems. Tables held clocks, automata and instruments, illustrating that man was increasingly able to fathom the interaction between heavenly and earthly powers.

Fig. 1
ATTRIBUTED TO WENZEL JAMNITZER (FRAME) AND AN UNKNOWN PAINTER, *Table Ornament with a Painted Map of the Iberian Peninsula*, late sixteenth century. Silver-gilt (frame), rock crystal, gold and lapis lazuli (painting), diam. 61 cm. Amsterdam, Rijksmuseum, inv. no. BK-17007.

Unlike modern museums, these treasure chambers were not open to all and sundry. To gain access to the famous *Kunstkammer* of Emperor Rudolph II (1552-1612) in Prague, for instance, was considered an extraordinary honour. On such an occasion the cabinet doors were opened and the treasures were taken out of their cases.[2] The unlimited funds and the close personal interest of the ruler enabled artists to give free rein to their creativity in costly materials, using unusual techniques and complex iconographic programmes.

The 'Spanish Map' in the Rijksmuseum is just such a *Kunstkammer* or cabinet piece (fig. 1). It is a round painted map of the Iberian Peninsula, geographically very accurate, depicted in gold and surrounded by clear blue seas. The towns and provinces are identified by their coats of arms. The image was painted on the back of sheets of rock crystal, which rest on a slate slab, supported in turn by a brass mount. The edges are concealed by a silver-gilt frame, and the piece rests on six winged creatures, likewise silver gilt. The unusual size, the subject and the costly materials make it a true *Kunstkammer* artwork.

Neither the map nor the base are marked or signed and nothing is known about the object's provenance before 1935, giving rise to speculation about the date, the makers and the

purpose of the object.[3] The earliest working hypothesis on the authorship and purpose of the work of art was proposed by Klaus Pechstein, silver specialist at the Germanisches Nationalmuseum in Nuremberg. In 1985 he conjectured that there might be a connection to a table centrepiece that Wenzel Jamnitzer (Vienna c. 1507-Nuremberg 1585) supplied to Nuremberg city council in 1549. Pechstein interpreted the two works as objects that the council had intended as gifts for the Holy Roman Emperor Charles V (1500-1558), or for his heir Philip II (1527-1598), King of Spain. He argued that because, contrary to expectations, the Habsburgs never went back to Nuremberg after 1541, and the objects were too costly to be reused for any other visitor, they never reached their destination and thus remained in the possession of the city of Nuremberg until the early nineteenth century.[4] He suggested that Jamnitzer had made the frame and that the reverse glass painting had been done by an anonymous Nuremberg artist. In 1991, Frieder Ryser, collector of and specialist in reverse paintings on glass, supported Pechstein's opinion on the purpose of the object. He dated the work to the mid-1540s and attributed the painting to the famous Nuremberg-born cosmographer, surveyor, mathematician and glass painter Augustin Hirschvogel (Nuremberg 1503-Vienna 1553).[5] However, given that Jamnitzer's 1549 centrepiece,

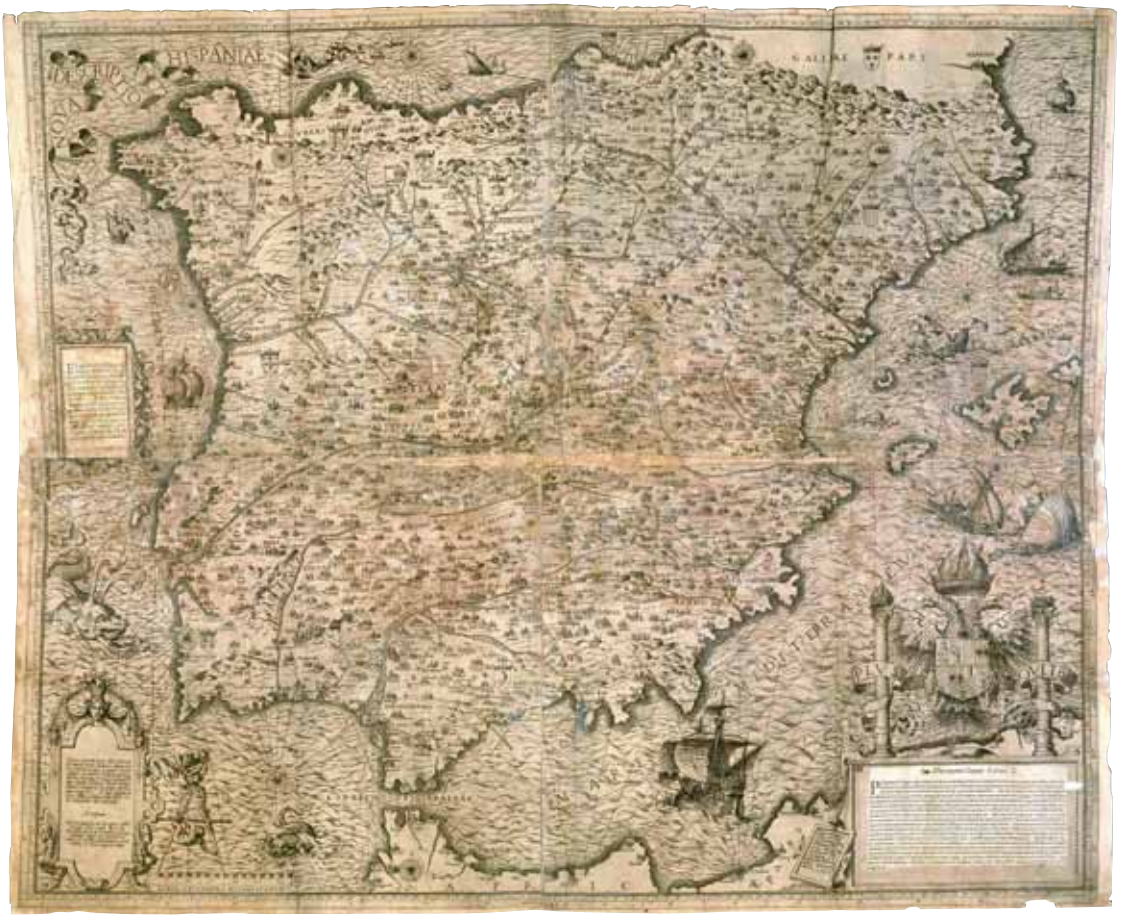


Fig. 2
HIERONYMUS COCK,
Nova Descriptio Hispaniae, 1553 (scale: 1:1, 400,000 cm). Engraving, 768 x 950 mm. Madrid, Biblioteca Nacional de España, Biblioteca Digital Hispánica.

Fig. 3
The painted map of the Iberian Peninsula.

which is also in the Rijksmuseum collection (see fig. 4), can be identified in the accounts and in the town's inventories until 1806, the 'Spanish Map' might be expected to figure in the same sources. Regrettably this is not the case, so neither Pechstein's nor Ryser's hypothesis is generally accepted.

A Dominican Monk and Cartographer

In the absence of documentary sources, other ways must be found to test Pechstein's and Ryser's hypotheses. The dating of the map provides an important starting point. In 2007 Sven Hauschke suggested taking the cartography of the Iberian Peninsula as a guide. If details that had not yet been charted in the 1540s could be seen on the painted map, it would mean that the *Kunstkammer* object must have been made later. The closest parallel to the painted map that Hauschke found was a printed version in the 1586 Portolan Atlas made by the Venetian cartographer Antonio Milo.

He consequently dated the painted version to the 1580s, thereby rejecting the attributions of the silver-gilt frame to Wenzel Jamnitzer and the painting to Augustin Hirschvogel. Both had died by that time.[6]

The history of the cartography of the Iberian Peninsula is complex, however, and for this reason it was a considerable time before it became clear when and by whom the peninsula was first mapped with modern measuring methods.[7] Atlases prove not to be the most obvious sources, since many of the maps they contain were copied from larger examples. As Günther Schilder demonstrated in 1978, new discoveries were sometimes published as wall maps first.[8] The results of his research into this – extremely rare – material radically changed ideas about the history of the cartography of the Iberian Peninsula. He showed that Antonio Milo's 1586 map in the Portolan Atlas had a number of earlier predecessors. This means that the Rijksmuseum's 'Spanish Map' could have been made earlier after all.

Vincenzo Paletino (c. 1508-1571) proves to have been a prominent figure in the history of the cartography of the Iberian Peninsula. This adventurer, born in what is now Croatia, went to South America in the train of Hernàn Cortès (1485-1547) and joined the Dominican Order there. The order first sent Paletino to Spain and afterwards offered him the opportunity to study theology in Bologna. During his travels through Spain and Portugal he collected information about the location of mountain ranges and rivers, and built up a network of correspondents. Shortly before 1550, while he was in Bologna, Paletino compiled a new map of the Iberian Peninsula based on his own observations and information supplied by others. By 1550 it was so far advanced that he was able to show his results. The scholars compared his results with the existing maps and were so impressed that in 1551 they gave Paletino the opportunity to publish his map in Venice.

Paletino was a highly regarded and versatile scholar. From 1555, for example, he was attached to the illustrious society of the Accademia Olimpica in Vicenza, where he occupied himself with mathematics, cosmography (the relationship between geography and the star system) and navigation.[9] The measurements he published were rapidly disseminated. One early example is the Antwerp *Nova Descriptio Hispaniae*, for which the engraver Hieronymus Cock (1518-1570) made the designs in 1553 (fig. 2). He stated in the legend that he had based his map on Paletino's.[10]

When the Rijksmuseum's painted map of the Iberian Peninsula is compared with Cock's map the similarities are striking (fig. 3). All the same, there can be no question of a direct copy. The arms of the various provinces and towns, which feature largely in both examples, are normal phenomena in cartography, so the painter did not necessarily borrow these elements from the Antwerp wall map. Various details were executed differently. For example, the painter changed Lisbon into a modern fortress with bulwarks after Italian models from the 1540s and 60s.[11] It is also interesting that Cock did not depict the lines which extended over the land in the painted version. This indicates that the painter must have known Paletino's map. The lines, which crisscross the seas and the land, are actually the result of marine cartographic measurement methods that Paletino chose as a starting point for his map. The crossing points for the west and east coasts indicate the two most important navigation points, from which the measurements of the Iberian Peninsula were calculated.[12]

A Frame by Wenzel Jamnitzer

If Paletino's map is used as a date *post quem* for the *Kunstkammer* object, it is obvious that none of the recently formed working hypotheses entirely hold water. Ryser's suggestion of dating the map to the 1540s is impossible because the scientific data on which the map is based was not available until around 1553. The attribution of the painting to Augustin Hirschvogel is problematic for the same reason, as he died in February 1553.

On the other hand it is highly plausible that Wenzel Jamnitzer made the silver-gilt elements of the frame. This famous silversmith was at the peak of his career around 1553. The ornament and the architectural structure of the frame can be linked to pieces made by Jamnitzer, including the similar friezes in the original presentation drawing of the huge centrepiece he made in 1549 (fig. 4) and a number of other silver objects (see figs. 11, 12). The earliest use of a very similar frieze we know of can be found on a writing case dated 1562 in the treasury of the former Saxon Electors, the Grüne Gewölbe in Dresden (fig. 10).[13]

The attribution to Jamnitzer is underpinned by the fact that he often incorporated paintings in the same technique in his compositions. They were usually small, relatively simply decorated rock crystal plates with coats of arms and ornaments. In the mid-sixteenth century they were mounted in the sides of small display cabinets, surrounded by silver frames marked or signed by Jamnitzer.[14] The question remains where these paintings were made. Obviously they could have been made in Nuremberg, but it is also possible that these small pieces were made outside the city and then imported. As the frame for the map must have been made to measure, a degree of coordination between silversmith and painter would have been essential. Even then, it is not certain that they both worked in the same city; it is just as possible that the consultations were dealt with by letter or through a middleman.

A Kunstkammer piece for the Spanish court?

The question as who the map was intended for can only be answered in general terms. The inventories of various Central European *Kunstkammern* have been published over the last few decades. The often highly detailed descriptions of the objects reveal how rare objects with painted decorations on glass or rock crystal were in the sixteenth century. In the majority of cases very few objects are listed.[15] Even Rudolph II's inventories made in the early seventeenth century

Fig. 4
WENZEL JAMNITZER, *Mother Earth (Merkel) Centrepiece*, 1549. Silver, partly gilded, and enamel, h. 99.8 cm. Amsterdam, Rijksmuseum, inv. no. BK-17040-A.

list only a couple of examples in this technique. However, none of them was the same size as the example now in the Rijksmuseum – or as expensive.

Pechstein's hypothesis that the 'Spanish Map' was intended for the Spanish court needs further research. The object cannot be identified from the published inventories of King Philip II of Spain, who died in 1598.[16] It may already have changed hands before the end of the sixteenth century. This was not unusual; if a gift had to be made, it was quite often a piece taken from one's own treasury. For example, the famous gold salt by Benvenuto Cellini (1500-1571), which he made around 1543 for the French king Francis I (1494-1547), disappeared from the Paris *Kunstkammer*. Francis's grandson, Charles IX (1550-1574), gave it to his Habsburg in-laws when he married in 1570, and as a result the salt can now be admired in the Kunsthistorisches Museum in Vienna.

We know that there was a great interest in cartographic innovations at the Spanish court, which is why Paletino was at pains to show his measurements to four Spanish bishops residing in Italy in 1550.[17] One of them, Francisco de Navarra y Hualde (1498-1563), was a member of Charles V's court, and Paletino consequently dedicated his map to the emperor. The emperor was in touch with cartographers and cosmographers and we may therefore assume that he took a personal interest.[18] His involvement is also evident in the Antwerp display map of the Iberian Peninsula, which was marketed in 1553 with imperial privilege and the mention of Paletino's data.

As early as 1920, Marc Rosenberg published an oeuvre catalogue of Jamnitzer's work, based on thorough knowledge of the most important collections, both royal and private, he had studied in Paris, London, Russia, Austria and the German Empire.[19] The map of the Iberian Peninsula does not appear in his overview. The fact that there is no trace whatsoever of the object in periodicals and sale catalogues before 1935 probably means that it was still in a private collection that was difficult to access.

Such a collection may well have been a historical one. Were this to be the case, the object would not have suffered much in the way of wear and tear, and one would therefore expect to find traces of a slowly progressing process of decay, and of one or more interventions to stop it. As there is no reason to doubt the rock crystal painting or the silver-gilt elements of the frame, the focus of the recent research has been on repairs and or later reinforcements. This means that examination of the materials used in them is the best tool for dating the different elements of the base.

The Metal Base of the 'Spanish Map'

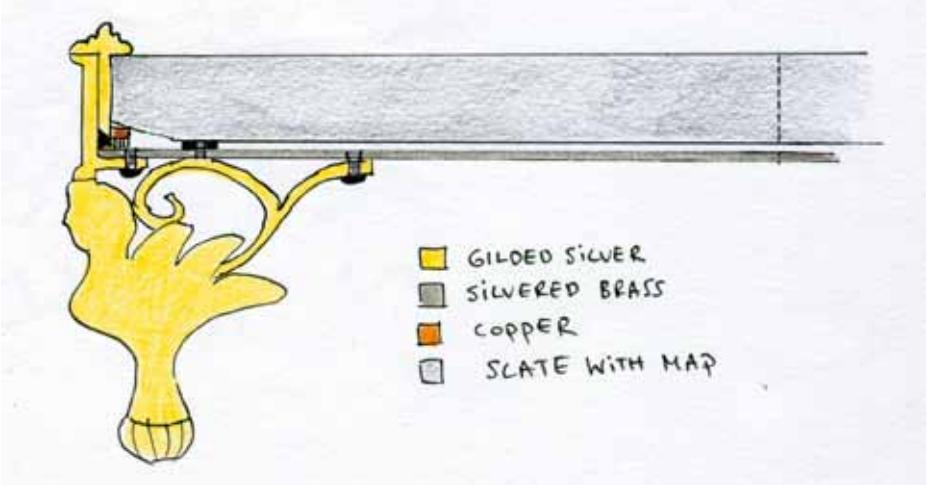
The base that holds the rock crystal map is essentially made up of five pieces: an ornamental silver-gilt frame, consisting of a frieze to which six legs are attached with bolts, a silvered openwork support, a slate slab on which the painted map rests, a narrow copper inner ring secured with screws underneath the slab; and a silver-gilt mount that secures the map to the base. There is a leather strip between the slate and the mount that acts as protective packing to hold the assembly securely (figs. 5, 6). All the parts were analysed with X-ray fluorescence (XRF) and X-radiography.[20]

The first question this threw up related to the large, silver-coloured openwork support: could a big piece of such uniform thickness have been made in the sixteenth century and, if so, how? It is 59.5 cm in diameter and 3.5 mm thick. It would be extremely difficult to hammer out a support of this size and maintain a regular thickness at the same time. An X-radiograph can reveal whether the metal had been compacted by hammering in some

Fig. 5
The base of the 'Spanish Map', upside down so that the attachment of the feet to the openwork support can be seen.

places. Hammer marks would show up as a different shade of grey from areas where the metal had been worked more lightly or not at all. However, the x-ray produced a remarkably consistent image: there was no discernible difference in thickness anywhere. In all likelihood, therefore, the plate was rolled. It has, as we have seen, been suggested that the frame was made by Wenzel Jamnitzer (c. 1507-1585), but although contemporary sources tell us that this technique was known in his day, wide rollers that could cope with a large plate did not come into general use until later.[21]

Fig. 6
Diagram of the construction of the base (illustration: Joosje van Bennekom).



Further examination using electron microscope analysis (SEM) revealed that the support was not in fact made of solid silver, but relatively 'fine' brass (approximately 65% copper and 35% zinc – percentage weights) that had been silver plated. Brass had been in quite general use since Roman times, but the zinc content usually did not exceed 28%.[22] The high zinc content and the size of roller that would have been required for the support of the 'Spanish Map' led us to suspect that it was not made until after the sixteenth century.

This conclusion is supported by the fact that the average thickness of the layer of silver on the brass is about 10 µm (approximately 0.001 mm; fig. 7). It was probably applied by electroplating.[23] This method of gold- or silver-plating brass or copper was not used on any sort of scale until the mid-nineteenth century. Furthermore, the tiny bolts with which the support is screwed to the ornamental frame proved to have been made to the Whitworth standard.[24] The thread type made according to this standard was accepted throughout Europe in the second half of the nineteenth century.[25] It can therefore be assumed that the support was made in or after the nineteenth century.

The copper ring between the support and the 1.72 cm-thick slab of slate on which the painted map rests proved to have been forged and to consist of virtually pure copper with a very little lead and no traces of any other elements.[26] This means, unfortunately, that it is impossible to establish a date for the copper; in any event, though, it does not appear to be very modern – the ring was probably made before the twentieth century.

Tiny bolts were used to attach the ring to the support, which can be tightened so as to hold the map securely and sit snugly in the base. These bolts cannot be accurately dated and may date from the same period, but could equally well be later.[27]

The ornamental frame with the lion's head frieze was also investigated (figs. 8-10).

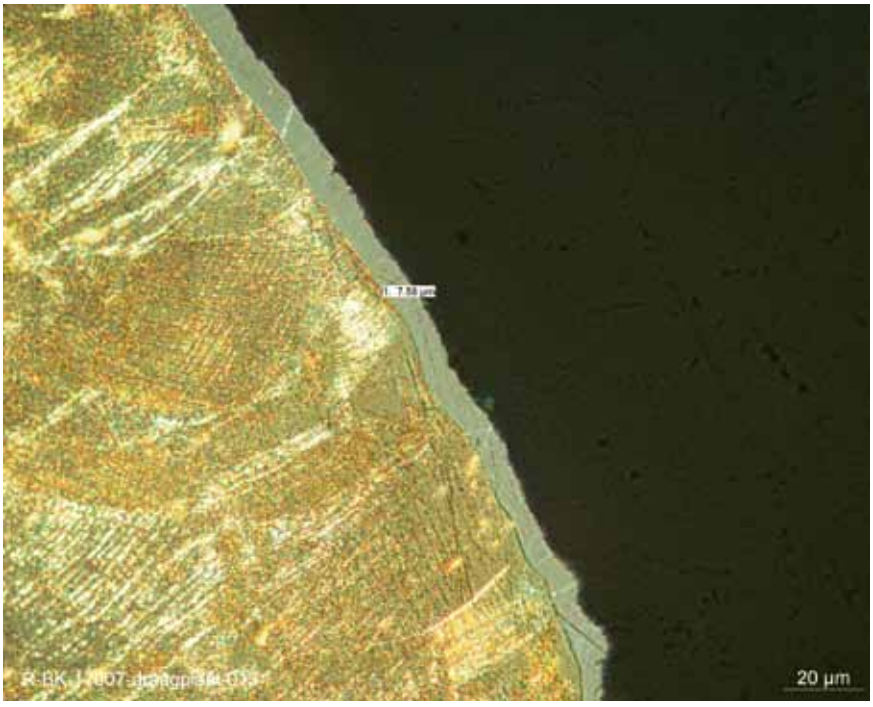


Fig. 7
Microscope photograph of a small area of the surface of the support.

Fig. 8
The ornamental border with lion's head frieze and one of the six feet in the shape of a sphinx.

Fig. 9
Close up of part of the ornamental border.

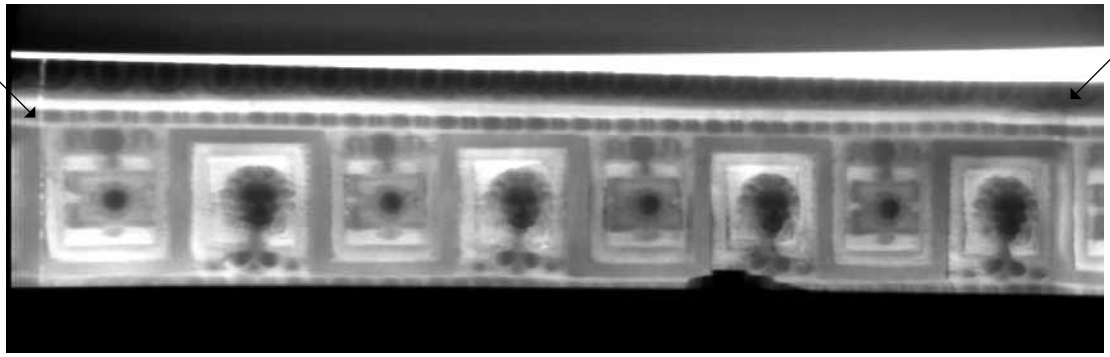


Fig. 10
X-radiograph of one segment of the ornamental border. Each segment, 9.5 cm high, consists of eight alternating figures. The arrows show the soldered seams.

Fig. 11
A similar ornamental border to the one on the 'Spanish Map' on a silver writing case by Wenzel Jamnitzer, 1562.
Dresden, Staatliche Kunstsammlungen Dresden – Grünes Gewölbe.
Photo: courtesy Dirk Weber.

Fig. 12
A similar ornamental border also occurs on a silver ornamental box by Hans Straub, c. 1593/94-1602.
Berlin, Staatliche Museen zu Berlin – Kunstgewerbemuseum.
Photo: Saturina Linke.

Fig. 13
A design for a lion's head frieze from a sketchbook attributed to Jamnitzer.
Berlin, Staatliche Museen zu Berlin, Kunstbibliothek, inv. no. 97/94, p. 9.
Photo: Dietmar Katz.

As we have seen, Jamnitzer made a similar ornamental border on a writing case in Dresden in 1562, and they can also be found on other objects from his circle (figs. 11, 12). The attribution of the lion's head design to the Nuremberg silversmith would appear to be supported by a sketchbook by him, now in Berlin (fig. 13).[28]

One such frieze was reused in the nineteenth century and appears on a goblet from the workshop of the Genevan goldsmith Johann Karl (Silvan) Bossard (fig. 14).[29] It has been

suggested that this might be a copy, and even that it could have been made from the lead model said to have come from Jamnitzer's workshop that is now in the Amerbach Collection in Basel (fig. 15).[30] Although at first this would appear to be wild speculation, it actually proves to be the case.[31] The presence of the lion's head frieze on the 'Spanish Map' – taken in conjunction with the other art historical arguments – is one of the reasons why the base is attributed to Jamnitzer. The occurrence of the ornamental border on a nineteenth-century piece made it important to subject the frieze to particularly close scrutiny.[32]

It is to be expected that new parts (added from the nineteenth century onwards) would have fewer impurities in the silver, because the metal refining process continually improved.[33] The quantities of gold,[34] lead and bismuth[35] are good indicators. In the case of the frame, the analysis method used included the gold in the gilding layer, so that it is unclear whether this element was part of the original alloy. Unfortunately the bismuth content cannot be measured accurately enough with this technique either. Lead, on the other hand, is a usable element. There is no lead in modern silver, but in older silver (from before about 1850) there is always a little (average 0.1-1% in Germany) and it was found to be one of the components of the ornamental frieze. The silver also proved to contain quite a high level of copper in comparison with first quality silver, but that turned out to have been standard practice in Nuremberg.[36] The solder that had been used contained silver, copper and zinc, in which traces of lead were also found. The same applied to the solid-cast silver-gilt feet.

Fig. 14
A similar ornamental border to the one of the 'Spanish Map' also occurs on a nineteenth-century silver covered goblet by Johann Karl Bossard, 1893. Lucerne, Historisches Museum, inv. no. LM-68007.

Fig. 15
The lead model thought to be from Jamnitzer's workshop, possibly the original form for the ornamental border of the 'Spanish Map'. Basel, Historisches Museum, Amerbach Collection.
Photo: courtesy Rainer Baum.

Conclusions to Date

The data that have been established – the high zinc content, large diameter and electroplated silver layer tell us that the support probably dates from the nineteenth century or later, and the

copper ring underneath the slate slab also appears to be quite modern – do not necessarily mean that the ornamental frieze is not sixteenth century and does not come from Nuremberg. The facts that its alloy might have come from Germany before about 1850 and the silver itself is certainly not new must be the deciding factor for the moment. Close examination of the nineteenth-century border of the Bossard goblet also revealed that it differs in details and lacks quality compared with the border of the frieze of the Spanish Map and the other earlier friezes; this makes it less likely that the Spanish Map frieze could be a copy taken from the Amerbach lead model. A thorough comparison of the known ornamental friezes may give us a more precise idea of where they were produced and their age.[37]

A particularly striking feature of the construction of the 'Spanish Map' is the design of the copper inner ring. It means that the slate slab is actually 'hanging' in the base, rather than supported by it (see also fig. 6).[38] This fact and all the other research results lead to the conclusion that – in any event at some time in the nineteenth century – work has been done on the object. There might have been another, better fitting construction in the past – for example a wooden support that did not prove strong enough – which was later replaced with the present silvered openwork support.

NOTES

1 The conservation of the metal base was carried out by Joosje van Bennekom in the Rijksmuseum's metal restoration department. Simone Bretz restored and conserved the reverse glass painting in her restoration workshop in Munich.

2 B. Bùcikova, 'Bekannten, unbekannten Raum, die Kunstkammer Rudolfs II im Prag', in H. Schramm (ed.), *Kunstkammer Laboratorium, Bühne. Schauplätze des Wissens im 17. Jahrhundert*, Cologne 2003, pp. 199-226.

3 The earliest reference can be found in the manuscript of the catalogue of the F. Mannheimer Collection which Otto von Falke compiled between 1935 and 1936. For the collector see M.D. Haga, 'Mannheimer, de onbekende verzamelaar', *Bulletin van het Rijksmuseum* 22 (1974), pp. 87-95.

4 K. Pechstein, 'Römischer kaiserlicher Majestät Goldschmied, zum 400. Todestag Wenzel Jamnitzers', *Kunst und Antiquitäten* 3 (1985), pp. 24-33.

5 F. Ryser, *Verzauberte Bilder, die Kunst der Malerei hinter Glas von der Antike bis zum 18. Jahrhundert*, Munich 1991, p. 315.

6 S. Hauschke, 'Goldschmiede als Hersteller wissenschaftlicher Instrumente und Geräte', in K. Tebbe et al., *Nürnberger Goldschmiedekunst 1541-1868*, exh. cat. Nuremberg (Germanisches Nationalmuseum) 2007, vol. 2, pp. 216-32.

7 R. Amalgià, 'The First Modern Map of Spain', *Imago Mundi* 5 (1948), pp. 27-31.

8 G. Schilder, *Monumenta Cartographica Neerlandica*, Alphen a/d Rijn 1987, vol. 2, pp. 95-96.

9 R. Gallo, 'Fra Vincenzo Paletino da Curzola e la sua carta della Spagna', *Atti della Accademia Nazionale dei Lincei* 1947, pp. 259-67.

10 Schilder, op. cit. (note 8), p. 96.

11 For the reception of the Italian fortress construction in Spain from the 1540s see M. Viganò, *El fratin mi ynginiero, I paleari Fratino da Morcote, ingegneri militari ticinesi in Spagna (XVI-XVII secolo)*, Belinzona 2004.

12 With thanks to Jeroen van der Vliet, the Rijksmuseum's curator of model ships and scale models.

13 Tebbe et al., op. cit. (note 6), vol. 1, p. 204, no. 15.

14 Jewellery box, c. 1559-70; ibid., vol. 1, p. 203, no. 9; K. Pechstein, *Wenzel Jamnitzer und die Nürnberger Goldschmiedekunst 1500-1700. Goldschmiedearbeiten – Entwürfe, Modelle, Medaillen, Ornamentstiche, Schmuck, Porträts*, exh. cat. Nuremberg (Germanisches Nationalmuseum) 1985, p. 224, no. 19. Display cabinet, 1556, made into a reliquary in 1570; Tebbe et al., op. cit. (note 5), vol. 1, p. 203, no. 10; C. Iglesias,

Felipe II. Un monarca y su época. La monarquía hispanicá, exh. cat. Madrid (Real Monasterio de San Lorenzo de El Escorial) 1998, p. 517, no. 254, fig. 264.

15 L. Seelig, 'Werke der Hinterglasmalerei in Goldschmiedefassungen, zur einer wenig beachteten Gattung des Kunsthandwerks der Spätrenaissance', in H. Lanz, *Farbige Kostbarkeiten aus Glas, Kabinettstücke der Zürcher Hinterglasmalerei 1600-1650*, exh. cat. Munich (Bayerisches National-museum) 1999, pp. 75-103.

16 F.J. Sánchez Cantón, *Inventarios reales, bienes muebles que perteneciéron a Felipe II*, 2 vols., Madrid 1956/59.

17 Francisco de Navarra y Hualde; Pedro Vaguer (?-1556), Bishop of Alghero (Sardinia); Juan Salazar Fernández (1493-1555), Bishop of Lanciano (Abruzzen); Pedro Agùstin y Albanell (1512-1572), Bishop of Huesca (Spain). For their biographies see the relevant entries in the *Encycopedia Catholica*.

18 M.R. Morales, 'Los cosmografos flamencos y Carlos v', *Revista Historia Naval* 18 (2000), no. 70, pp. 7-25.

19 The map is also missing from Rosenberg's 1925 list; M. Rosenberg, *Goldschmiede Merkzeichen*, Frankfurt 1925 (3rd revised ed.), vol. 3, no. 3832, pp. 53-61. This is all the more remarkable because Marc Rosenberg was regarded as the foremost Jamnitzer specialist of the early twentieth century.

20 XRF makes it possible to determine all the elements in an alloy because the electrons in the metals that are present become excited and return to their usual state with a specific energy. X-radiography makes it possible to look through the metal and see the composition and structure of the object.

21 J. Daniels and C. Daniels, 'The Origin of the Sugarcane Roller Mill', *Technology and Culture* 29 (1988), no. 3, pp. 493-535.

22 P. Craddock, *Scientific Investigation of Copies, Fakes and Forgeries*, Oxford 2009, pp. 147-48.

23 If a metal is suspended in a solution of its salts and negative current is passed through it, the dissolved metal ions will attach to the metal. There are in any event no indications that the silver was applied with a solder or by 'fusing', and the silver layer is too thick (maximum is 0.5 µm) for electrochemical replacement silvering. French plating – heating the object to be plated and rubbing silver foil 'into' the brass – can also be ruled out, as no joins can be discerned between the leaves of foil on the surface of the object. See T.P.C. Beentjes, 'An Introduction to Silver Plating in 18th-century Europe', in *Metal 07. Proceedings of the International Conference on Metals Conservation*, vol. 1, Amsterdam 2007, pp. 17-21.

24 In 1841 the English engineer and inventor Sir Joseph Whitworth (1803-1887) designed the first standardized screw thread, later known as the British Standard Whitworth or BSW. From then on bolts and screws were 'cut'. The threads around the bolt and inside the nut are at a specific angle and are a fixed distance apart for each type.

25 Information supplied by Tonny Beentjes, lecturer in metal restoration at the University of Amsterdam.

26 Copper usually contains some silver. This was extracted by means of the liquation process, which involved adding a lot of lead to absorb the silver. This process was known in the mid-sixteenth century and was used until well into the nineteenth century. At the end of that century processes were developed to refine copper electrolytically. Craddock, op. cit. (note 6), p. 140.

27 The bolt thread proved to be an unidentifiable type, with a pitch in accordance with British Association (BA) 5, but with a thinner shank.

28 K. Pechstein, 'Jamnitzer Studien', *Jahrbuch der Berliner Museen* 8 (1966), pp. 237-83. More detailed comparison revealed that there are too many significant differences: the sketch also features the head of a woman, the striking meander band is absent and the lion's head looks more like a ram's head.

29 Silver-gilt goblet, 1873. Zurich, Schweizerisches Landesmuseum, inv. no. LM-68007 COL-6669.

30 Basel, Historisches Museum. The Amerbach Collection was assembled in the late sixteenth century and contains models used by Nuremberg silversmiths from that century on. It includes a bronze model of a bukranion relief with alternating cow's skulls, columns and shields that is also found in Jamnitzer's work. Apparently, there was never any record from the outset as to which ornaments came from Jamnitzer's workshop (information supplied by Tonny Beentjes).

31 See E.-M. Lösel, '"Unserer Väter Werke" – zu Kopie und Nachahmung im Kunstgewerbe des Historismus', *Unsere Kunstdenkmäler* 1986, no. 37, pp. 19-28. It emerges that the firm of Bossard did indeed use a number of moulds from the

Amerbach Collection. With thanks to Hanspeter Lanz, curator at the Schweizerisches Nationalmuseum, who drew this article to my attention.

32 The lead model consists of segments that are likewise 9.5 cm long, but have seven instead of eight alternating figures (see fig. 9). This anomaly is remarkable and cannot readily be explained. The top of the lion's mane in the lead model sometimes touches the first framing line in the cartouche – the line is, as it were, pushed upwards. This is not, however, the case with the 'Spanish Map' (although its frieze is very worn and the high points are badly flattened in several places; the fire gilded silver must have been subjected to frequent polishing). A detailed photograph of the lead model clearly shows that the ornament has 'degenerated'; forms that originally had a function have now lost it: the nails that secure the lion's head have become a sort of flower, and the eyes from which the designs between the lion's heads 'hang' from ribbons are no longer recognizable as such.

33 From around 1874 very pure silver was obtained by means of the electrochemical process invented by Emil Wohlwill, a chemist from Hamburg.

34 Craddock, op. cit. (note 5), pp. 388-89: 0.1% Au Middle Ages, 0.05% Au late Middle Ages, 0.01% Au nineteenth century.

35 E.L. Richter, 'Der Silberpokal aus der Saigerhütte zu Grünthal in Sachsen,' *Restauro* 3 (1994), pp. 188-93. In this article Richter prints two graphs showing the lead and bismuth content of silver objects made in Germany down through the centuries. The average bismuth content was between 0.005 and 0.1%.

36 U. Timann, 'Zur Handwerkgeschichte der Nürnberger Goldschmiede', in Nuremberg 2007, op. cit. (note 13). In 1540 the Council of Goldsmiths decreed that silverware had to have a purity of 14 lot, with a tolerance of 1 quint. This means 875 parts silver and 125 parts copper. Comparative alloy research into Dutch and other silver in, for instance, the collection of the Centraal Museum Utrecht (Van den Bergh-Hoogterp, coll. cat. Edele Metalen, Utrecht (Centraal Museum) 1997) shows that an alloy of about 800/000 to 850/000 is normal for German silver, in contrast to, say, Dutch silver, where alloys of between 900/000 and 940/000 are usually found.

37 The ornamental friezes with this pattern could be examined with 3D laser scanning – which measures the object very precisely – and X-radiography. ICP-MS, lead isotope and trace element analysis could likewise provide more clarity about the place of manufacture, the exact make-up of the alloy and the period when this alloy was used.

38 It was decided not to pack this gap with supporting material; the map has been held securely in this manner until now, and altering the design might create new problems.

Detail of fig. 1