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The Materials and Condition of the Last Judgement Mosaic of Prague Cathedral*

For Maria with affection

The recently cleaned Prague mosaic (Figs. 1–4) presents a series of problems typical of medieval mosaics elsewhere. Although studies of style and meaning abound, too little has been done for an understanding of the nature of the materials and how they were used. The reason for this, as I am sure you are well aware, is that so few samples for analyses have been taken and at that, quite sporadically and often incompletely examined. For instance, for the Florentine Baptistery only 13 samples were analyzed—all from the early 14th century mosaics in the gallery.¹ None were taken from the earlier vault mosaics. At the Sancta Sanctorum in

Rome, for the 13th century mosaics, elaborate studies were carried out for the identification of the pigments, but nothing at all was done to tell us what types of glass were involved.² For the history of mosaics and their various states of conservation, as well as for the history of technology, the sources of raw materials and so on, this lack of information represents serious lacunae.



Fig. 1. Prague, Cathedral of St. Vitus. The mosaic after cleaning and regilding by Getty Conservation Center and Czech conservators.



Fig. 2. Prague Cathedral. Central panel of the mosaic after regilding.



Fig. 3. Prague Cathedral. Detail of the central panel. Christ of Last Judgement.



Fig. 4. Prague Cathedral. Detail of the left panel. The Blessed.

There are, however, rare exceptions: such as San Vitale in Ravenna and a corner of the atrium of San Marco in Venice. I refer, of course, to the work of Cesare Fiori and Marco Verità,³ two physical chemists. These cases concern the identification of glass as well as pigments. Other studies, but again there are far too few of these, take a more archaeological approach concerning the ways tesserae were set as well as distinguishing between original pieces and those added during subsequent restorations. I am thinking especially of Irina Andreescu-Treadgold's work at San Vitale and Torcello.⁴ But even here we have no report regarding the type or types of glass used at these sites.

Hopefully in the case of Prague's golden portal the story will be different thanks to the Getty Conservation Center and the Prague restorers. We need all the information we can get if we are to understand what we are looking at and how the work can best be taken care of.

Before coming to questions concerning the technique and condition of the Prague mosaic, we should briefly review what is known of their historical context and what it shares with other examples of the period. As you know, contemporary chronicles inform us that the mosaic was made in 1370–1371 at the behest of the Emperor of Bohemia, Charles IV, who had just returned from an Italian visit.⁵ The royal nature of this commission was entirely in keeping with the use of the medium elsewhere. Mosaics were so costly and prestigious that it was still a medium reserved for monarchs, popes and such rich republics as Venice and Florence. What would Charles have seen in Italy to inspire the Prague commission? Concentrating on façade mosaics in Rome, he would still have seen those at Old St. Peter's, St. Paul's outside the Walls, the Lateran, Giotto's *Navicella* and Santa Maria Maggiore as well as the façade mosaic of San Frediano in Lucca (see note 5). Then, he might have seen the façade of Orvieto Cathedral and St. Mark's in Venice where work was still in progress.

To create such mosaics a large supply of tesserae was needed. As for the glass tesserae, this presumed the existence of a local glass industry because the quantity was such that it would have proved impractical to import them. The only stable glass industries in Italy then were at Murano and Gambassi in Tuscany.⁶ Although Murano at times exported small quantities of tesserae to Orvieto, for instance, production was limited and there were occasions when there were not enough to supply the mosaicists at St. Mark's.⁷ Pisa cathedral, on the other hand, had a supply of surplus tesserae which occasionally were sold to Florence.⁸ But it is unknown who produced them—some were made in situ and others were purchased from vendors.⁹ Probably, glass works for stained-glass windows and tesserae were created for specific projects which when completed were dismantled. This was the case at Orvieto about which a great deal is known thanks to the studies of Catherine Harding and Lucio

Ricetti.¹⁰ As for Bohemia, in Charles IV's time, Hettes informs us that there were at least 20 glass factories in the area so that glass for the tesserae for St. Vitus could have come from nearby.¹¹

In many respects the Prague mosaic and those originally at Orvieto Cathedral have much in common. Both are façade mosaics—Orvieto's measures about 121 square metres and Prague's about 85 square metres.¹² Both are roughly contemporary and both used tesserae of stone as well as glass. Carlo Bertelli has even suggested that some of the Orvieto mosaicists might have contributed to the Prague mosaic either via designs or actual setting in situ.¹³ Whether Prague also used terracotta or recycled tesserae (i.e. spoils) remains to be seen. Also the type of glass used in both monuments seems to have been the same: potassic glass but there might have been other types of mixed alkalis as well.¹⁴

Potassic glass is less durable than soda glass—the kind preferred in Venice.¹⁵ Obviously, façade mosaics are subject to weathering which is particularly hard on potassic glass because water leaches out the alkali more easily from the glass mix.¹⁶ Why, then, was potassic rather than soda glass used in Orvieto and Prague?

It is well known that the Venetians had a virtual monopoly on soda glass which used either natron (a mineral rich in soda imported from Egypt) or plant ash high in soda content—the *lumen catino* shipped to Venice from Syria.¹⁷ The Venetians passed laws from 1275 onwards through the 14th and 15th centuries, prohibiting its sale or export.¹⁸ Interestingly enough, there may have been an attempt at Orvieto to circumvent this difficulty by purchasing some Venetian tesserae. A well known document of 1360 describes how an emissary was sent to Venice for the purchase



Fig. 5. London, Victoria and Albert Museum. Birth of the Virgin, detached mosaic from façade of Orvieto Cathedral.

of 660 pounds of tesserae in various colors and shades.¹⁹ Since we know that glass tesserae were also being produced at the time in Orvieto itself, can it be that it was only the hue of the Venetian tesserae that mattered? Is it possible that the more stable nature of the Venetian soda glass was a factor as well?

A very rough calculation of how much 660 lbs of glass tesserae would make in terms of a mosaic surface—turns out to be about 12 square metres or about 10% of the Orvieto façade mosaic.²⁰ So far, no soda glass tesserae have been identified among the ruined remains of the Orvieto mosaics (Fig. 5) but this may be due to lack of analysed samples.²¹ In any case, the late Trecento documents tell us that the façade mosaics there made by Orcagna and others were defective because they were badly set and discolored. Hardly were the individual scenes finished than repairs and restorations ensued.²² For a complete study of their complicated history, see the recent article by Giulio Manieri Elia and Paul Tucker.²³

What kinds of glass were used elsewhere in Italy for 13th and 14th century façade mosaics? The fact is we don't know and this goes for Lucca and Florence as well as for Rome.

As for interior mosaics during the same period of time: soda glass and natron do turn up in the late 13th century mosaics at Santa Maria in Trastevere.²⁴ Were these tesserae manufactured then, or could they be spoils—recycled from other sites? In Florence, potassic glass was used for the early 14th century mosaics in the Baptistry's gallery.²⁵ If potassic glass was used throughout the Baptistry vault, this would partly explain its poor condition and the many heavy restorations it has endured.

What is known of another essential ingredient in glass tesserae—the silica? What came from river sand and what came from quartz bearing pebbles? Can one deduce from what rivers or mountains this material may have come from? Silica from sand tends to be less pure than from pebbles and would have required different preparations.

And what of the metal oxides used for the coloring? Is it possible to distinguish between 14th-century tesserae and later ones inevitably introduced to replace the losses?

Returning to Prague. What about the plaster used? Luigi Solerti, a Venetian mosaicist, who was in Prague in 1879, distinguished a layer of lime and crushed brick as well as another vaguely indicated as an area of lime and marble dust.²⁶ Both types of plaster were conventional. Matějček writing in 1915 mentions two layers of plaster.²⁷ This brings us to the matter of earlier restoration campaigns. There may have been one in 1478.²⁸ A fire occurred in 1541 with unknown consequences for the mosaics.²⁹ It has been said that the mosaic was whitewashed in 1619.³⁰ Matějček mentions restorations before 1832 and 1837 but no documentation for these is known to me.³¹ Later on in the century, the mosaics were deliberately abraided to get

rid of the whitish deposits ascribed to oxidation—an operation which must have further weakened the condition of the tesserae.³² In 1857 and 1890 pieces of the upper border fell down. Soon afterwards, in 1890 it was decided to detach the entire mosaic and repair it.³³ Twenty years later in 1910, the mosaic was returned to its original site.

The frequency of restorations throughout the 19th and early 20th centuries occurred when Prague was still part of the Austro-Hungarian empire. Moreover, this coincided with a general revival of interest in mosaic manufacture all over Europe. There is the Albert Memorial in London, mosaic schools were founded in Paris, Munich and Innsbruck.³⁴ Between 1836 and 1845 mosaics were stripped from the walls of churches in Murano, and Ravenna and then sent to Potsdam and Berlin.³⁵ Wittelsbach castles were adorned with new mosaics. Luigi Solerti, the Venetian mosaicist, who consulted on the Prague mosaic between 1879 and 1890 was also involved with the mosaic schools in Innsbruck and Munich.³⁶ Could it be that the work done on the St. Vitus mosaic was part of a widespread mosaic revival? Would it be possible to recognize the hands of the various restorers involved by a study of Solerti's and other mosaicists' work elsewhere? Andreescu was able to pick out the work of Moro and Salvati in areas of the Torcello mosaic.³⁷ Moreover, scientific means exist today for distinguishing between old and new tesserae.³⁸

Now to the big question: in view of the nature of the Prague mosaic with its potassic tesserae, its exposure, its frequent restorations, how much can really remain of the 14th-century mosaic? Italian façade mosaics such as Santa Maria Maggiore in Rome and Orvieto Cathedral have been re-worked many times over. Could the Prague mosaic have escaped similar treatment? Throughout the mosaic there are notable inconsistencies in the setting of the tesserae. More than forty years ago, Karl Hettes noticed that a number of the St. Vitus tesserae had a bevelled wedge shape known in Italy as *tessere a cuneo*.³⁹ The only other examples known to me of this type date from the 5th century at Galla Placidia in Ravenna.⁴⁰ Could these Prague tesserae be spoils? Other instances of recycled tesserae are well known going back to Carolingian times: at Aachen and in Rome at Santo Stefano Rotondo, Sant Prassede and San Clemente.⁴¹

Hettes also noted another interesting feature in the Prague mosaic: the different color of the support glass for the metallic tesserae (Fig. 6). Red predominates in the central panel giving the main scene a warmer glow while dark green and blue were used for the flanking mosaics.⁴² It is known that red glass without lead in it is not ideal for the adherence of metal foil (does the Prague mosaic have lead in its red support tesserae?). Green and blue glass are better in this respect.⁴³ In fact, this is mentioned in a 15th-century mosaic treatise published by Milanese in the 19th century.⁴⁴ Were the Prague mosaicists aware of this? Another question:



Fig. 6. Prague Cathedral. View of mosaic after cleaning and before regilding by the Getty Conservation Center and Czech conservators.

which was set first? The figures or the gold ground?

All of these queries and comments concerning the Prague mosaic amount to a plea for thorough scientific and archaeological examination.⁴⁵ An inventory of all the different materials used would be a good beginning (if this has not been done already). But the plea for Prague could just as well as be addressed to mosaics in Italy, Greece, Turkey and Russia. Clearly, we are only at the beginning of such studies.

Notes

- * My thanks to Prof. Eliska Fucikova for photographs and for the Czech literature. As well as to my colleagues, Fiorella Gioffredi Superbi and Giovanni Pagliarulo for further help of all kinds.
- 1 VERITÀ, Marco: *Tecniche di fabbricazione dei materiali musivi vitrei: indagini chimiche e mineralogiche*. In: *Medieval Mosaics: Light, Color, Materials*. Eds.: Eve BORSOOK, Fiorella GIOFFREDI SUPERBI and Giovanni PAGLIARULO. Cinisello Balsamo, 2000, pp. 57, 60.
- 2 MOIOLI, Pietro – SCARPÉ, Raffaele – SECCARONI, Claudio – TOGNACCI, Attilio: *Studio delle paste vitree utilizzate nei mosaici della cappella del Sancta Sanctorum*. In: Carlo PIETRANGELI (ed.): *Sancta Sanctorum*. Milano, 1995, pp. 280–290. Up to 1957 no really satisfactory analysis had been made of ancient glass of any date from Rome or elsewhere in Italy; CALEY, Earle R.: *Analysis of Ancient Glass, 1790–1957*. Corning, N.Y., 1962, pp. 13, 94.
- 3 FIORI, C.: *Studio della composizione e del degrado dei materiali musivi dell'arco presbiteriale di S. Vitale a Ravenna*. In: A.M. IANNUCCI et al (eds.): *Mosaici a S. Vitale e altri restauri: il restauro in situ di mosaici parietali*. Atti del Convegno, Ravenna 1–3 October 1990. Ravenna, 1992, pp. 43–53; VERITÀ, Marco: *Analisi di tessere musive vitree del Battistero della Basilica di San Marco in Venezia*. In: Ettore VIO and Antonio LEPSCHY (eds.): *Scienza e tecnica del restauro della Basilica di San Marco*. Atti del convegno internazionale di studi, Venice 16–19 May 1995. Venice, 1999, II, pp. 567–585.
- 4 ANDREESCU, Irina: *Torcello III. La chronologie relatives des mosaïques parietales*. In: *Dumbarton Oaks Papers No. 30* (1976), pp. 246–341; ANDREESCU-TREADGOLD, Irina: *The Mosaic Workshop at San Vitale*. In: IANNUCCI et al (see note 3), 1992, pp. 30–41.
- 5 MATĚJČEK, Anton: *Das Mosaikbild des Jüngsten Gerichtes am Prager Domes*. In: *Jahrbuch des Kunsthistorischen Institutes der K.K. Zentralkommission für Denkmalpflege*, 9(1915), p. 118. See also: Seidel, Max: *The Power of Images. Lucca as an Imperial City: political iconography*. Munich – Berlin, 2007, passim. Charles visited Lucca for several months between 1368 and 1369.
- 6 ZECCHIN, Luigi: *Vetro e vetrai di Murano. Studi sulla storia del vetro*, 3 vols. Venice, 1987, 1989, 1990; MENDERA, Marja: *Produzione vitrea medievale in Italia e fabbricazione di tessere musive*. In: BORSOOK et al (see note 1), 2000, pp. 132 ff; BORSOOK, Eve: *Un mistero musivo*. In: G. FOSSI (ed.): *Arti fiorentine: la grande storia dell'artigianato. II medioevo*. Firenze, 1998, pp. 164, 169–171.
- 7 BORSOOK, *Introduction*, 2000 (see note 1), p. 12.
- 8 NOVELLO, Roberto Paolo: *I mosaici*. In: A. PERONI (ed.): *Mirabilia Italiae: Il Duomo di Pisa*, III. Modena, 1995, p. 286 f. Mendera, 2000, p. 136 f.
- 9 HARDING, C.D.: *Facade Mosaics of the Dugento and Trecento in Tuscany, Umbria and Lazio*. PhD. thesis, University of London, 1983, pp. 215–218.
- 10 IDEM: *Economic Dimensions in Art: Mosaic versus Wall Painting in Trecento Orvieto*. In: P. DENLEY and C. ELAM (eds.): *Florence and Italy: Renaissance Studies in Honour of Nicolai Rubinstein*. London, 1988, pp. 505–507; IDEM: *The Production of Medieval Mosaics: the Orvieto Evidence*. In: *Dumbarton Oaks Papers No. 43* (1989), pp. 76–79; RICCETTI, Lucio (ed.): *Il Duomo di Orvieto*. Bari, 1988; IDEM: *'Fare di necessità virtù'. L'uso delle tessere in ceramica nei mosaici del Duomo di Orvieto nei secoli XIV–XV*. In: FRANCISCI OSTI, O. (ed.): *Mosaics of Friendship: Studies in Art and History for Eve Borsook*. Florence, 1999, pp. 61–74.
- 11 HETTES, K.: *La verrerie en Tchécoslovaquie*. Prague, 1958, pp. 3–4, and unpaginated diagram entitled “The Development of Glass-Making on the Territory of the Kingdom of Bohemia”; HEJDOVA, Dagmar: *Glassmaking in the Archaeological Finds in the Territory of Czechoslovakia*. In: *VII^e Congrès International du Verre*, Brussels 1965, no. 248; IDEM: In: *Czechoslovak Glass Review*, 12 (1966), p. 253; PHILIPPE, Michel: *Naissance de la Verrerie Moderne XII^e – XVI^e siècles*. Turnhout, 1998.
- 12 MATĚJČEK, 1915, p. 107; HARDING, 1988, p. 512.
- 13 BERTELLI, Carlo: *Rinascimento del Mosaico*. In: C. BERTELLI (ed.): *Il Mosaico*. 2nd ed. Milan, 1999, p. 225.

- 14 HETTES, 1958, p. 4; VERITÀ, 2000, pp. 57, 60.
- 15 In fact, Venice in 1306 forbade use of potassic ash for glass; ZECCHIN, III, 1990, p. 172; CASTELNUOVO, Enrico: *Vetrate medievali. Officine, tecniche, maestri*. Turin, 1994, pp. 423.
- 16 HREGLICH, S. – VERITÀ, M.: *Study on the Corrosion and Colour of potassium Glass – Church of SS. Giovanni e Paolo, Venice*. In: *CV Newsletter*, 31/32 (1980), pp. 16–23; IDEM: *Applications of X-ray Micro-Analysis to the Study and Conservation of Ancient Glasses*. In: *Scanning Electron Microscopy*, 2 (1986), pp. 488–489; Verità, M. – Toninato, T.: *A comparative analytical Investigation on the Origins of Venetian Glassmaking*. In: *Rivista della Stazione Sperimentale del Vetro*, 20 (1990), p. 169; VERITÀ, M.: In: Cristiana MOLDI RAVENNA (ed.): *I colori della luce: Angelo Orsoni e l'arte del mosaico*. Venice, 1996, p. 190; IDEM: *Guide, Abstract, unpaginated typescript: Deterioration Mechanisms of ancient Soda–Lime–Silica Mosaic Tesserae*. 18th International Congress on Glass, July 5–10, 1998, San Francisco, Cal.
- 17 VERITÀ – TONINATO, 1990, pp. 173 f.; JACOBY, David: *Raw Materials for the Glass Industries of Venice and the terraferma about 1370 – about 1460*. In: *Journal of Glass Studies*, 35 (1993), pp. 65–90; Verità, 1999, pp. 571–574 (see n. 3 above).
- 18 ASHTOR, Eliyahu – CEVIDALLI, Guidobaldo: *Levantine Alkali Ashes and European Industries*. In: *The Journal of European Economic History*, 12 (1983), pp. 490, 501–503, 513; ZECCHIN, III, 1990, p. 172.
- 19 FUMI, Luigi: *Il Duomo di Orvieto e i suoi restauri*. Rome, 1891, p. 122, doc. XLIII; HARDING, 1989 (see note 10 above), pp. 80, 93.
- 20 This calculation is based on an ancient Roman vault mosaic where according to Stern 6000 pounds of glass tesserae would have sufficed to cover about 100–109 square metres of walls and vaults in the public bath at Oxyrhynchus without counting the space between the cubes (about 20%), STERN, E. Marianne: *Roman Glassblowing in a cultural Context*. In: *American Journal of Archaeology*, 103 (1999), p. 466. The Orvieto mosaics came to about 121 square metres; HARDING, 1988, (see note 10 above), p. 512.
- 21 VERITÀ (in BORSOOK et al., 2000 [see note 1 above], p. 172) notes that glass panes of potassic and soda types appear side by side sometimes in the Orvieto Cathedral windows.
- 22 FUMI, 1891, pp. 106, 108, 140–141; HARDING, 1989, p. 87; IDEM: *La Produzione musiva nei Duomo di Orvieto*. In: Guido BARLOZZETTI (ed.): *Il Duomo di Orvieto e le grandi Cattedrali del Duecento*. Atti del convegno internazionale di Studi, Orvieto 12–14 November 1990. Turin, 1995, p. 197; SCHLEE, L.: *Problemi cronologici della Facciata del Duomo di Orvieto*. In: same volume, p. 112.
- 23 MANIERI ELIA, Giulio – TUCKER, Paul: *Reliquie, rappezzature, falsificazioni: vicende critiche e materiali del mosaico con la Natività della Vergine, già sulla facciata del Duomo di Orvieto*. In: *Ricerche di Storia dell'arte*, 73 (2001), pp. 21–36. For further information concerning the condition and migration of the ruined Orvieto mosaics I am much indebted to the kindness of Peta Motture, Deputy Curator of Sculpture at the Victoria and Albert Museum in London who sent me a copy of the article by Alberto SATOLLI: *Il mosaico del Duomo al Victoria and Albert Museum*. In: *La Città*, September 2000, pp. 6–13 published in Urbino.
- 24 Verità, 2000, (see note 1 above), p. 56.
- 25 IBID., p. 57.
- 26 MATĚJČEK, 1915, p. 116.
- 27 IBID., p. 107.
- 28 IBID., p. 112.
- 29 IBID., p. 113.
- 30 VITOVSKÝ, Jakub: *[Prague] Cathedral*. In: *The Dictionary of Art*, XXV. London, 1996, p. 442.
- 31 MATĚJČEK, 1915, p. 114.
- 32 VERITÀ, M. – FALCONE, R. – VALLOTTO, M. – SANTOPADRE, P.: *Study of the weathering Mechanisms and chemical Composition of ancient Mosaic Tesserae*. In: *Rivista della Stazione Sperimentale del Vetro*, 6 (2000), pp. 33–4; VERITÀ, M.: *Technology and Deterioration of vitreous Mosaic Tesserae*. In: *Reviews in Conservation*, 1 (2000), pp. 65–76.
- 33 MATĚJČEK, 1915, p. 116f.
- 34 HARDING, C. D.: *Mosaic*. In: *The Dictionary of Art*, XX. London, 1996, pp. 158, 163.
- 35 The apse mosaics from S. Cipriano in Murano and S. Michele in Africisco, Ravenna; RIZZARDI, Clementina: *Mosaici alto-Adriatici*. Ravenna, 1985, p. 129, n. 1.
- 36 *Thieme–Becker Künstlerlexikon*, XXV. Leipzig, 1931, p. 409; *Ibid.*, XXXI. Leipzig, 1937, p. 241; RIZZARDI, 1985, p. 129, n. 1; IANNUCCI, Anna Maria: *Appunti per una storiografia del restauro parietale musivo. Il caso di Ravenna*. In: IANNUCCI et al (see note 3 above), p. 21. For further information on Solerti, see Gabriella BERNARDI: *I Mosaici della Basilica Eufrosiana di Parenzo: documenti per la storia dei restauri (1862–1916)*. Rovigno / Trieste, 2005.
- 37 ANDREESCU (see note 4 above), 1976, pp. 246–341.
- 38 VERITÀ, 1999 (see note 3 above), p. 584.
- 39 HETTES, 1958, p. 3; FIORENTINI RONCUZZI, Isotta: *Il mosaico: materiali e tecniche dalle origini ad oggi*. Ravenna, 1984, p. 150.
- 40 FIORENTINI RONCUZZI, 1984, p. 150.
- 41 BORSOOK et al., 2000, pp. 13, 203; BASILE, Giuseppe: *Il mosaico absidale di S. Clemente a Roma*. In: *Ibid.*, p. 152; VERITÀ, 2000, same volume, p. 64.
- 42 HETTES, 1958, p. 3. The red glass in the central panel, along with the green and blue grounds on ei-

ther side, were regilded during the Getty sponsored conservation campaign.

- 43 VERITÀ, 2000 (see note 1 above), p. 52. Green glass as a base for metal foils found also in the S. Zeno Chapel of S. Prassede in Rome (OAKESHOTT, W.: *The Mosaics of Rome from the Third to the Fourteenth Centuries*. London, 1967, p. 11); as well as S. Maria in Trastevere (CANTONE, Rosalba: *I mosaici della facciata di Santa Maria in Trastevere a Roma. Note e prime risultanze di restauro*. In: IANNUCCI et al. 1992, see note 3 above, p. 235; see also John GAGE: *Colour and Culture*. London, 1993/4, p. 275 n. 41 for examples at Pula, Ravenna and Aachen). Very dark green glass also found beneath gold foil mosaic in a XIII century portable mosaic in Cortona (MONCIATTI, Alessio: *La Vergine orante dell'Accademia Etrusca di Cortona. Nuovi dati e considerazioni su un mosaico toscano del Duecento*. In: *Prospettiva*, 87–88 (July–Oct. 1997), pp. 107–108 notes.
- 44 MILANESI, Gaetano: *Dell'arte del vetro per mosaico, tre trattatelli dei secoli XIV e XV per la prima volta pubblicati*. Bologna, 1864, pp. 3–5 from the first treatise.
- 45 I have been unable to consult *Conservation of the Last Judgment Mosaic, St. Vitus Cathedral, Prague* edited by F. PIQUÉ and D.C. STULIK. Los Angeles, Getty Conservation Institute, c. 2004.