9th International Conference on NDT of Art, Jerusalem Israel, 25-30 May 2008
For more papers of this publication click: www.ndt.net/search/docs.php3?MainSource=65

THE MURAL PAINTINGS OF THE AJANTA CAVES, PART I: DOCUMENTATION ON EXECUTION TECHNIQUES AND CONSERVATION CONDITION

Annamaria Giovagnoli[1], Francesca Capanna[1], Marcella Ioele[1], Anna Maria Marcone[1], Emanuela Ozino-Caligaris[1], Lidia Risotto[1], M. Singh[2]
[1]Istituto Centrale per il Restauro – Piazza S. Francesco di Paola 9– 00184 Rome Italy
[2]Ajanta Caves, Fardapur, 431118, Maharashtra, India Tel e fax 0091 2438 244234

ABSTRACT

The archaeological site at Ajanta, in India, is in the region of Maharashtra about an hour's flight from Mumbai and two hours' drive from Aurangabad, the capital of the province of the same name.

The rock complex of Ajanta is renowned for its splendid mural paintings that are unique for their entirety and state of preservation within the panorama of ancient pre-Islamic Indian art. It comprises twenty-nine Buddhist caves cut into the steep curved rock face flanking the gorge formed by the Waghora River.

This paper is the result of a technical and conservation data collection programme carried out in Cave 17 of this important heritage site following agreements signed in January 2005, between Italy, officially represented by the Italian Embassy in India and Ministry of Culture (comprising the Istituto Centrale per il Restauro [ICR] within its organizational structure), and the Indian authorities, represented by the Ministry of Culture and the Archaeological Survey of India [ASI].

During the first and second missions, ICR conservators conducted a survey of the execution techniques and conservation condition of significant areas of the wall paintings, using a structured methodological approach to recording data and producing graphic documentation for the conservation of this cultural property, drawing on ICR's wide experience in the sector and aware of the principle that correct preventive action requires documentation of all the material, artistic and historical knowledge on the site as a basis for assessing its conservation condition and the treatments that need to be carried out.

The conservation survey and graphic documentation enables us to gain a comprehensive knowledge of the constituent materials and execution techniques, as well as to identify the forms and causes of deterioration in assessing the conservation condition of the site. The data produced from these investigations will provide the groundwork for selecting the most suitable materials and methods to adopt for the treatment programme.

CONSERVATION DATA RECORDING

In the case of the Ajanta mural paintings, given the time available and the logistic difficulties involved (that likewise affected the preparation of graphic documentation), the north-west section of the cave, which the local experts indicated as being particularly problematic, was chosen for recording data.

Six conservation data record cards were drawn up relating to: the west wall portico, left side of north wall portico, internal west wall, left side of internal north wall, left side of internal south wall and second pilaster of north wall entrance.

The conservation and technical data collected was firstly filled in on paper forms, and then computerized and stored in an easily accessible database in order to enable the future correlation of analogous information collected from other areas of the same site. It goes without saying that the methodology used for data collection and its storage followed standardized criteria.

A high degree of analytical planning was involved in defining the contents of the current conservation data record card, particularly in the sections describing constituent materials,

execution techniques and factors of alteration, trying at the same time to maintain a logical organization of the data to facilitate its subsequent input and retrieval.

Two different levels of information were determined:

- a basic level designed to record only information considered essential with regard to the entries indicated, which make use of both coded data and text fields, always however bound by a controlled use of vocabulary, syntax and punctuation;
- a secondary more detailed level for open-ended text fields in order to supplement, justify and document the basic data provided, if and when necessary.

In order to facilitate the input and retrieval of data from the text fields, a guide for the compilation of the data record card was drawn up. For each entry the guide explains the type of data considered essential, the technical vocabulary to adopt and cites a series of illustrative examples showing the type of syntax and punctuation required. The program used was File Maker Pro 7.1 produced by the Claris Corporation.

The data record card is divided up into six sections:

1. Reference data. This contains basic information relating to the work in question (geographical location, description of object/site, measurements, author, period, etc.). The section ends with a paragraph on the methods of inspecting the painting (visual, tactile, examinable support), which is of fundamental importance for assessing the integrity and completeness of the survey.
2. Documentation. This section contains the necessary documentary references relating to the work of a graphic, photographic or written (bibliographical or archival) nature.
3. Position/display characteristics. The information contained in this section is brief and acquired through simple visual examination as it will be presented in greater detail on the environmental data record card.
4. Technical data and conservation condition. This is the most technical and analytical section of the sheet, in that it presents all the visually deducible data on the constituent materials, execution techniques and conservation condition of the painting.
   The section is divided into three parts presenting data that refers to the individual layers or elements ideally comprising the work: support structure, preparatory layers, and paint layers.
   The collection of data for each individual section is carried out in the same order. First, the constituent materials and execution techniques are examined, and then the alterations linked to factors of deterioration of a physico-chemical and biological nature, and lastly the restoration treatments carried out in the past. An “Other” entry is always included to provide for those less common aspects not specified in the other fields. As far as the indicated factors of alteration are concerned, an assessment of the extent of the damage is recorded and a calculation, expressed in percentage, of its distribution in relation to the overall surface.
5. Indication of treatment programmes. Based on the previously recorded documentary, technical and conservation elements, this section proposes the treatment programmes that need to be carried out, indicating the type and degree of urgency. Five different time-related categories were specified for this purpose:
   - emergency treatment: urgent intervention in order to temporarily arrest or limit any further deterioration until such time that a subsequent restoration programme may be implemented;
   - short-term treatment;
   - medium-term treatment;

- long-term treatment;
- maintenance and inspection.

6. Record card data. This section indicates the names and job titles of the record card compilers, the date of compilation as well as that of any reviews or updated entries.

In this project the section relating to foreseeable treatment programmes (5) has not been filled in, given the partiality and the essentially cognitive purpose of the survey.

GRAPHIC DOCUMENTATION

Theme-related mapping of areas identified as being affected by different conservation situations have been correlated with the conservation data record card.

Theme-related tables have been drawn up relating to:

- west wall of portico, one test of 4 m^2 (ca.)
- internal north wall, two test of 4 m^2 (ca.) each
- internal west wall, two windows of 4 m^2 (ca.) each
- internal south wall, one window of 4 m^2 (ca.)
- internal pilaster 4 (numbering of laser scanner survey), one window of 2 m^2
- internal vault, one test patch of 4 m^2 (ca.).

During the organizational stage of the work, the original plan was to carry out a laser scanner survey of the whole of Cave 17 to be used as a graphic base for the theme-related mapping so as to be able to insert the data directly onto the PC in situ, eliminating the risk of transcription errors. Computerized graphic documentation systems in this organizational form have actually been in use for some time at ICR and we have included some examples of work sites for mural paintings by Paul Brill and Antonio Circignani in the Cappella del Bagno and ambulatory of the Church of S. Cecilia in Trastevere (Fig.1) as well as that of the Giotto paintings in the Scrovegni Chapel in Padua (Fig. 2) in which the author of this paper actively participated in the planning and execution of the work of documentation and restoration [1] .

Fig. 1 - S. Cecilia in Trastevere, Rome

Fig. 2 - The Scrovegni Chapel, Padua

The survey was actually carried out [2], but the lack of continuity in the supply of electricity in the archaeological area, made it very difficult to the use a portable computer the whole day long. The limited lighting and the nature of the wood structures made available to reach the higher areas of decoration necessitated, moreover, using easy and manageable recording instruments like pen and paper.

On the other hand, also solutions that demand a first recording on paper and then transcription onto PC have proved efficacious on diverse occasions [3] and, lastly, among the objectives of cultural cooperation between our countries is that of devising a method of approach that takes the availability of local resources into account.

The data presented is therefore provisional, with symbolic colours on acetate sheets placed over orthophotos, taken for this purpose by the photographer Edoardo Loliva, and on copies of line drawings done by Monika Zin and Matthias Helmdach and published in 1999 in the "Guide to the Ajanta paintings" available at the site. With this system, observations and recordings have been made together with the local experts who will now proceed to extend and complete the work already set in motion (fig. 3).

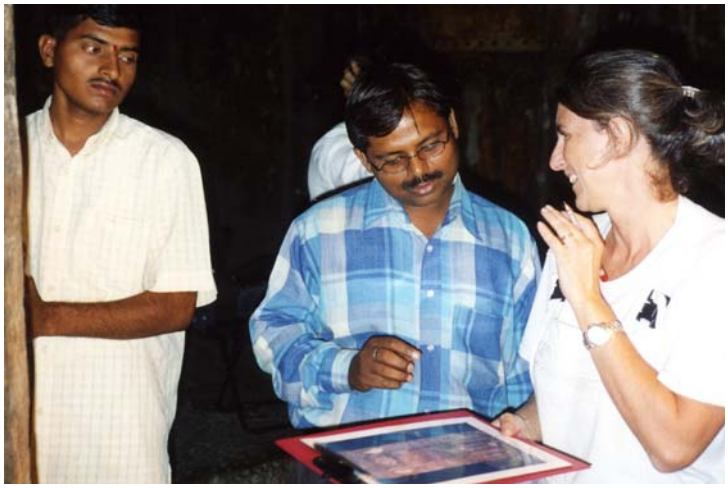

Fig. 3 - Cave 17, Ajanta, Maharashtra, India

The data was then transferred onto a digital support using the widespread software product (AutoCAD Autodesk map Series 2004). The precise execution of the acetates did not leave any room for doubt in the transcription phase. The working group decided to use the colour laser scanner as a raster base for the mapping. This proved to be extremely convenient during the data input phase for the precise topographical identification of the elements to be recorded, but the writer of the report believes that such an image instead disturbs the reading of the information at the consultation phase, and hopes that the photos will be replaced in future with an external line drawing (Fig. 4, 5).

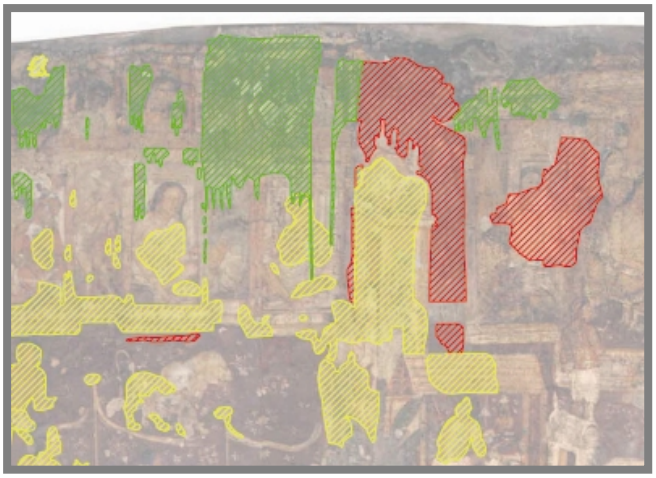

Fig. 4 - Cave 17, Ajanta, Maharashtra, India

Fig. 5 - The Scrovegni Chapel, Padua

The organization of the data was carried out using the structure set up at the ICR documentation department, which has been in operation since the work was done using only paper as a support. This is presented in a tree form in which the following can be identified: a *family*, a *species*, a *class* and possibly a *sub-class* [4].

There are four *families*: execution techniques; current condition, restoration treatments, and diagnosis. The first two are further subdivided into *species*: 'constituent materials' and 'methods of execution', the first; and 'conservation condition' and 'past treatments', the second. Within each *species* there are distinct *classes*, for example, in 'methods of execution' we find: 'working of preparatory layers (intonaco)', 'transfer of drawing', and 'pictorial layers'. Following this, some *sub-classes* describe the recorded data in more detail; for example, the 'preparatory layers' *class* under 'conservation condition' is further divided into data relating to 'stability' and 'losses'. Table 1 presents all the subjects used.

The theme-related tables illustrate data relating to the execution technique, conservation condition and past treatments for a total of about 33 subjects (6 execution technique, 22 current state, 5 diagnosis) even if not all of them are always present in each of the areas observed.

The graphic documentation has enabled the immediate visualization and localization of technical working and diagnostic data, so as to be able to assess the extent and distribution of conservation problems, also cross-referencing them in order to discover their logical connections. The transfer of data onto a digital support system has made two main functions possible: firstly, as a means of assessing the extent of a restoration work in the planning phase, calculating the percentage incidence of damage encountered and consequently the amount of treatments necessary; and secondly as a database and graphic memory.

The tables produced in this way are united in a more general Geographic Information System (GIS) that interfaces all the technical scientific data collected during the cognitive missions with the aim of establishing possible and necessary correlations [5].

Family	Species	Class and Sub-class		Subject
Execution technique	Constituent materials			
	Method of execution	Working of preparatory layers (intonaco)		Pontata
				Superimposition of layers
				Working marks on the intonaco
		Transfer of drawing		Direct incision on dry intonaco
				Preparatory drawing (brush or graphite)
		Pictorial layers		Pentimento
Current condition	Conservation condition	Preparatory layers	*Stability*	Cracks or fissures
				Lack of cohesion
				Lack of adhesion
				Lack of adhesion of the surface layers
				Deformation *(bulging)*
			Losses	Surface layer lacuna
				Abrasion
				Scratch *(human damage)*
		Paint layers	*Stability*	Lack of cohesion of the pictorial film
				Lack of adhesion of the pictorial film
			Losses	Abrasion
				Paint layer lacuna
				Area of microlacunae
				Scratch *(human damage)*
			Alterations	Chromatic alteration of pictorial film
			Surface deposits	White deposits
				Animal excrement
				Insect nests
	Past treatments	Preparatory layers	*Consolidation*	Injection hole
				Clamps or nails
			Reintegration of lacunae	Fill at same level
		Paint layers	*Restoration materials superimposed on original*	Fixative
Restoration				
Diagnosis	Sampling			Chemical
				Biological
	Point of investigation			Chemical
				Physical
				Photographic

Table 1. - Subjects used

CONCLUSIONS

Among the data recorded during the mapping of the technical and conservation data, it is worth underlining only certain important aspects.

It must be noted how in this work the number of symbols necessary to record the techniques for transferring the drawing was limited to two, compared to the many symbols necessary to describe the same class for frescoes of the Italian tradition (up to 9 symbols). They were just identified and recorded as: preparatory drawing (with brush) and direct incision on dry intonaco. The relative simplicity of transcribing the image is certainly prompted by the freedom of being able to carry out the pictorial decoration without the time restriction dictated by the drying of the intonaco. It is probable, however, that the limited variety of techniques also depends on a different approach to the execution of the work by the Oriental artist who, offering himself as a docile instrument of divine inspiration, leaves less space for the practical construction of the image.

The junction lines of the intonaco that define the extent of the *pontata* are not generally present; they have been identified in only two places and more precisely on the left half of the north wall and on the pilaster. This has raised certain questions regarding the methods of spreading the mortars: was a *caesura* half way up the wall acceptable, but made only in cases of necessity like, for example, the forced suspension of work or did it depend on the varying skills of the workmen?

Among the data recorded through conservation data recording and theme-related mapping, one can still cite the example of cataloguing the fills of the lacunae. Correlating the data emerging from UV observation (Fig. 5), different types of mixture and different surface treatment solutions were actually observed and recorded, which indicates the succession of restoration treatments during which different principles of integration were applied.

Fig. 5 Cave 17, Ajanta, Maharashtra, India Visible and UV light.

It was possible to identify five different types of fill.

1. White-coloured rather fine-grained mortar that, according to local experts, is made with ‘plaster of Paris’ (calcium sulphate dihydrate). It has been used to fill the small and medium-sized lacunae and also for protecting the original fragile mortar along the edges of the lacunae prior to reintegrating those of medium and large dimensions with grey or

reddish mortars. Under UV light it produces a slightly bluish fluorescence that could be indicative of lime. It always appears under the other mortars leading one to believe that it was the first to be applied and must therefore date back to the treatment operation in 1920 by Cecconi Principe.

2. Reddish or grey-coloured mortar whose aggregate may be sand or powdered local stone, while the binder may be lime, gypsum or cement. Used for repairing medium and large-sized lacunae and for consolidating the visible edges. Under UV light it produces a pinkish fluorescence mainly distributed in the central zone and not at the edges with a circular striped pattern that suggests the brush application of a protectant. The chemical analysis of a drip stain from the same fluorescence associates it with the same class of products as shellac. One may hypothesize that also this dates back to the work carried out by Cecconi Principe, who may have chosen coloured mixes to fill the large lacunae and then applied shellac as a final protectant.
3. Pink-coloured mortar. Used for repairing lacunae in the perimeter fills carried out with the mortar described in point 2.
4. Brown-coloured fine-grained mortar, very similar to the original, used by the current team of restorers to integrate minor losses in the preparatory layers. Under UV light it produces no fluorescence.

On the fills carried out with the mortar described in point 1, and perhaps on that indicated in point 4, chromatic surface treatments with covering or glazed colours are present at times. The treatment generally aims to reduce the disturbance in the reading of the pictorial text with a uniform application over the entire surface, although in some cases it may be considered in every respect a chromatic integration in tone (Fig. 6).

Fig. 6 - Cave 17, Ajanta, Maharashtra, India - reintegrated fills

Although it is not possible to establish a precise date for these retouchings, one can formulate hypotheses based on the observation of UV images. They were certainly carried out after the application of a transparent protectant (visible in the UV images as sizable drips with a pale yellow fluorescence), which though not analyzed is certainly different from the shellac that, as we have seen, produces a pinkish fluorescence. The retouchings appear on top of the drips interrupting the vertical path they leave on the wall. They are, however, earlier than the cleaning operations during which they were partially removed [6].

Because of the sporadic nature of their use, the pinkish mortar (3) and the one very similar to the original (4) both seem to be attributable to ordinary maintenance works that have

continued up to the present day. Other sporadic fills made with different mortar mixtures can similarly be attributed to maintenance works; they are superimposed on those identified with number (2), and difficult to group together in homogeneous categories.

The presence of so many different types of mortar to reintegrate the lacunae, apart from being indicative of scant methodological consistency, show that the fragility of the paint layers and, as a consequence, the lacunae worsen over time.

General phenomena of abrasion of the pictorial film, attributable to cleaning operations with over-abrasive systems, are evident in specific areas on the different walls; they seem more widespread on the north and west walls than on the remainder. This confirms what the analysis of the documentation relating to treatments carried out [7] revealed, that is, that restoration works in the cave have taken place little by little with the aim of treating limited portions of the paintings without maintaining the same conservation methods and, in any case, with different operators.

ENDNOTES

1. For the Church of S. Cecilia in Trastevere (1996) see: G. Buzzanca, F. Capanna, La documentazione grafica assistita da elaboratori: uno strumento per il restauro, in: "Bollettino dell'Istituto centrale per il Restauro", n. 1 anno 2000; for the Scrovegni Chapel (2001) see: G. Basile edited by, Il restauro della Cappella Scrovegni. Indagini, Progetto, Risultati, Milan 2003.
2. The survey was carried out by SAT Survey s.r.l. - Via Cappelletto 4, 30172 Mestre-Venezia – Director: Arch. Alberto Torsello; topography and laser scanning: Arch. Alberto Torsello, Arch. Giorgia Andreatta, Tommaso Masiero; direct and photographic survey: Arch. Giorgia Andreatta, Guido Malara; graphic layout: Arch. Giorgia Andreatta; digital image layout: Dott. Sara Favaretto; Eleonora Zambon; 3D model: Tommaso Masiero coordinated by Arch. Stefano D'Amico.
3. See, for example, similar cases like: J. Zheng, Documentation of Wall Painting in China, in W. Schmid edited by; Graphic Documentation Systems in Mural Painting Conservation, Seminario 16 – 20 November 1999, Rome 2000 pp. 97 – 105
4. M. Gorini, F. Sacco, Considerazione sui principi della documentazione grafica, in: G. Basile (edited by), "Pittura a fresco, tecniche esecutive, cause di degrado, restauro". Exhibition catalogue, Arezzo 1989 pp. 47-50; F. SACCO, Il problema della documentazione grafica dei restauri, in: "Materiali e Strutture", 1993, III, 1pp. 25-34.
5. Geographic Information System (GIS) managed by Carlo Cacace.
6. Gupta, P.C.; Nauni, B.P.. A method for the preservation of black outlines of figures drawn with lamp-black during removal of accretions of soot etc. from Ajanta wall paintings / In: Conservation of cultural property in India, Vol. 21, 1988, p. 14-16, Sharia, O.K.; Mangiai, R.R.; Tribade, R. Removal of copper nails and prefixing of painted surface in cave no. 17, Ajanta In: Conservation of cultural property in India, Silver Jubilee vol. , 1991, p. 27-33
7. See for example Sengupta, Rakhaldas; Conservation and restoration of mural paintings in India / In: International symposium on the conservation and restoration of cultural property - conservation and restoration of mural paintings (II) - November 18-21, 1984, Tokyo, Japan / Tokyo: Tokyo National Research Institute of Cultural Properties, 1985; or NAGPAL, J. G. The problem of the chemical conservation of Ajanta paintings. In: Conservation of cultural property in India, 1979.

BIBLIOGRAPHIC REFERENCES

1. G. Urbani, *Piano pilota per la conservazione programmata dei beni culturali in Umbria. Progetto esecutivo*, ICR, Rome 1976.
2. S. Angelucci, G. Martellotti, *Il rilevamento dello stato di conservazione dei dipinti del museo civico di Pistoia*, in Catalogo delle collezioni del Museo Civico di Pistoia, Florence 1982.
3. S. Papaldo, M. Ruggeri Giove, R. Gagliardi, D.R. Matteucci, G.A. Romano, O. Signore, *Strutturazione dei dati delle schede di catalogo. Beni mobili, archeologici e storico artistici*, ICCD, Rome 1985.
4. C. Olivetti, *Proposta di una Scheda per la raccolta dei dati nel restauro dei dipinti su tela*, "Quaderni degli Istituti Culturali della Provincia di Viterbo", 1 (1988), pp. 25-159.
5. M. Fileti Mazza, G. Rasario, M.G. Vaccari, *Organizzazione informatica della scheda di restauro*, "OPD Restauro", 2 (1990), pp. 49-66.
6. M. Cordaro, M.C. Mazzi, *Censimento conservativo dei Beni artistici e storici. Guida alla compilazione delle schede*, Centro Regionale per la Documentazione del Lazio, Rome 1993.
7. A.M. Marcone, M. Paris, G. Buzzanca, *A system for collecting data on canvas and panel paintings for the maintenance and the surveillance of a historical art collection in Rome*, in Preprints of the ICOM-CC 12th Triennial Meeting, Lyon 29 Aug -3 Sept 1999, vol. I, pp. 257-262.

Back to Top