Microchemical Journal 124 (2016) 719–725

Contents lists available at ScienceDirect

Microchemical Journal

journal homepage: www.elsevier.com/locate/microc

A multi-analytical study of ancient Nubian detached mural paintings☆

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ARTICLE INFO

Article history:
Received 3 August 2015
Received in revised form 19 October 2015
Accepted 19 October 2015
Available online 24 October 2015

Keywords:
NMR stratigraphy
NMR spectroscopy
SEM-EDS
Raman and IR spectroscopy
Detached mural paintings
Egyptian pictorial technique

ABSTRACT

A multi-analytical study was carried out on materials, techniques, and state of conservation of a set of detached Nubian mural paintings, originally belonging to the 10th century pictorial cycle of the church of Sonqi Tino, Sudan (70 km south of the Egypt–Sudan border). These paintings represent one of the very few examples of Christian Nubian pictorial cycles preserved from the wide defacement experienced by these artifacts with the building up of the Aswan Dam. Non-invasive NMR depth profiling was used to preliminary study the hydrogen rich layers of the detached mural paintings. By this technique, it was possible to perform a virtual coring with a reconstruction of the complex series of layers that characterize the investigated artifacts. Then, micro-sampling and cross-section examination by SEM-EDX, micro-Raman, micro-FTIR, and ^{27}Al and ^{29}Si MAS NMR, allowed us to shed light on materials and technology exploited by the Medieval Nubian painters, with the identification of pigments and composition of the original primer, obtaining also information on layering of materials used by conservators during the detachment of the paintings and their transfer to a new support. The combination of preliminary non-invasive investigation with a set of micro-invasive analytical techniques allowed us to set up a protocol for a satisfactory decoding of the multilayered complex systems that characterize the detached paintings.

1. Introduction

A multi-analytical study was carried out to investigate constitutive materials and state of conservation of a set of detached ancient Nubian mural paintings in permanent exhibition at Near East Museum of *Sapienza* University of Rome. The paintings were originally belonging to the 10th century pictorial cycle of the Nubian church of Sonqi Tino, Sudan (70 km south of the Egypt–Sudan border) and were detached during a UNESCO rescue campaign, just before the flooding of the area due to the rising of the Aswan Dam. The paintings were hastily removed and transferred to a new support using the so-called *strappo* (i.e. tear) procedure, a method of detachment that is practically never used in conservation, because considered dangerous, drastic, and irreversible [1,2]. Its application is only restricted to cases where the unique alternative is the complete loss of the artifact.

The *strappo* consists of a number of successive steps: 1) areas with de-cohesions of the pictorial film are preliminary fixed; 2) the surface to be detached is prepared (*facing*), gluing a thin canvas to the portion of the wall painting to be removed; 3) the *strappo* is carried out, with a removal that involves the pictorial layer which remains adherent to the glued canvas, but also thin and irregular layers of the underlying preparation; 4) the back of the detached mural painting is leveled off and consolidated; 5) another canvas is glued to the back of the consolidated painting, which is thereafter fixed to a rigid support (*backing*); 6) finally, the canvas of the *facing* is removed.

After the long procedure of the *strappo*, together with the pictorial film and preparation, all the inorganic and organic substances used during the transfer to a new support become parts of the artifact, which is finally composed by a complex multi-layered system of materials. This complexity renders any study of this type of detached paintings a real challenge.

In a previous paper [3], we have exploited different NMR analytical techniques to evaluate the feasibility of a non-invasive or minimally invasive approach to understand the sequence of layers of the final detached system and their composition. First, through *in situ* non-invasive single-sided ^{1}H NMR depth profiling, the whole stratigraphy has been investigated, leading to the identification of six distinguishable layers (L1–L6), then by ^{13}C CPMAS NMR spectroscopy the organic materials mainly constituting these layers (up to the new support) have been investigated through a detailed analytical examination via selective sampling.

☆ Selected papers presented at TECHNART 2015 Conference, Catania (Italy), April 27–30, 2015.

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http://dx.doi.org/10.1016/j.microc.2015.10.022
0026-265X/

In this paper, we extended and integrated the previous study to better check the variability of the various layers in the whole examined paintings, characterized the execution technique of the paints, and finally obtained a full overview of the exhibited artifacts in their current status.

For this purpose, further areas were non-invasively examined by single-sided ^{1}H NMR, some new regions were sampled, and in order to extensively identify the original inorganic and organic materials constituting the paintings, an integrated multi-technique analytical approach was followed exploiting scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS), micro-Raman, micro-FTIR, and ^{27}Al and ^{29}Si MAS NMR. In particular, to investigate the composition of the original pictorial film (L1) and the distribution of its elemental and molecular components, reflection-FTIR and EDS mappings on cross-sections were carried out.

In spite of the complexity of the systems investigated, the obtained results finally allowed us to shed light on the technique and materials used by Christian Nubian painters in Sonqi Tino. The data, compared with those recently obtained on other detached paintings from the area of Faras, Old Dongola, and Baganarti [4], greatly contribute in defining material and techniques practiced by Medieval painters of Nubian art.

2. Materials and methods

2.1. The case study

In 1966, UNESCO promoted the rescue of several Nubian archeological sites which would have soon been flooded by the river Nile due to the Aswan Dam raising. Within this framework, an archeological mission was organized to recover artifacts from Sonqi Tino, a village on the west bank of Nile river, at the south of the Egypt–Sudan present border. Four excavation campaigns took place between 1967 and 1970 with the aim of recovering the ancient Christian Nubian vestiges from the whole area, which included the church, the adjacent burying ground, and the Diff, a fortress built in an area at the south of Sonqi.

Fig. 1a shows a detail of the cob made church, photographed during the excavation campaign. According to the report of the archeological mission, the church was found to be partially sanded up, the masonry covered with a local mud for leveling off the surface and painted over a white thin preparation layer of lime. Apart the archeological reports based exclusively on visual observation, no written sources are available on the composition and technology of the Nubian wall paintings. To this lack of knowledge strongly contributed the wide, if not total, defacement experienced by most of these pictorial cycles during the time. Only very recently, a study parallel to this one has been carried out on the composition of paintings detached from churches of the Nubian areas of Faras and Dongola.

The paintings of the church of Sonqi Tino represent a chronological cornerstone in the history of Nubian painting. In fact, they are precisely dated due to the wishing inscription “Long life to King George” who reigned between 970 and 1003. They show relevant examples of the Christian iconography typical of this and other relevant Nubian archeological sites, such as those of Faras, Abdallah Nirqi, Abdel-Qadir, and Tamit. The representations include saints, kings, theological icons, and episodes from Old and New Testament.

During the removal work, the mural paintings appeared in a very compromised state of conservation, since they were found to be fragmented in many areas, at risk of collapse, and partly detached from the wall or pushed out by plant roots. Because of the forthcoming flooding, they were detached from the masonry and brought elsewhere. Nowadays, most of the detached Sonqi Tino mural paintings are in exhibition at the Sudan National Museum in Khartoum, one piece is at the Vatican Museums, and some others are at the Near East Museum of *Sapienza* University of Rome, where the preliminary *in situ* measurements of this work were carried out.

2.2. Unilateral NMR

^{1}H NMR stratigraphies were collected at 13.62 MHz with a unilateral NMR instrument from Bruker Biospin interfaced with a single-sided sensor by RWTH Aachen University, Aachen, Germany [5]. Experiments were carried out by repositioning the single-sided sensor in steps of 50 μm to cover the desired spatial range, from the outermost surface of the detached mural painting to a depth of 0.5 cm with a resolution of 57 μm, the magnetic field gradient was 14.4 T/m, 100 experimental points corresponding to 100 different depths were collected to obtain the profile; the number of scans was 256, the total scan time was 3.5 hours, the recycle delay was optimized at 0.5 s, the π/2 pulse width was 11 μs. The spatial resolution was obtained from the pulse width to the intensity of the magnetic field gradient ratio. The area of measurement was 2.5 × 2.5 cm^2.

2.3. Solid-state NMR

Samples were packed in 4-mm zirconia rotors with an available volume reduced to 12 μl, and sealed with Kel-F caps. The spin rate was 12 kHz.

Solid-state ^{13}C CPMAS NMR spectra were measured at 100.63 MHz on a Bruker Avance III spectrometer. The contact time for the cross-polarization was 1.5 ms, the recycle delay was 3 s, and the ^{1}H π/2 pulse width was 3.5 μs. Spectra were collected with a time domain of 1024 data points, and Fourier transformed with a size of 2048 data

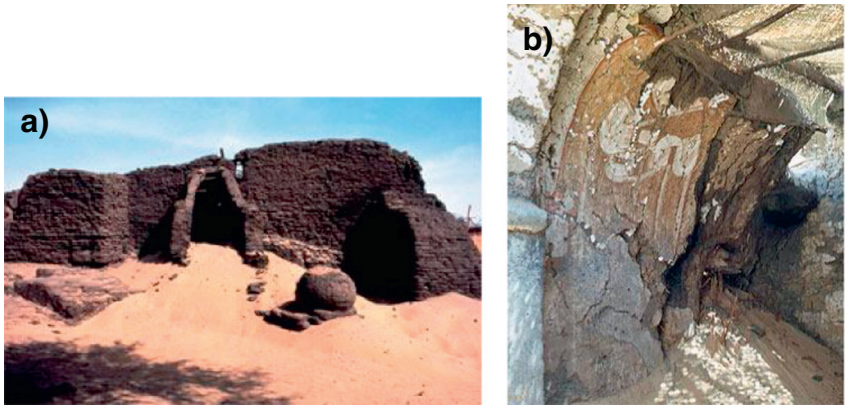

Fig. 1. a) A detail of Sonqi Tino church photographed during the excavation campaign. b) A mural painting found in Sonqi Tino Church. We acknowledge Prof. L.Sist and M.Necci for the pictures.