THE SURFACE OF ARTWORKS AND BEYOND "THE SPIRIT OF AN ARTIST"

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ABSTRACT

Art in its deep roots is an ancient science and science in its broad sense is a unique Art. The interrelated connection between art and science opens channels for deeper perception of art and more demand for technological innovations.

Artworks are the unique creation of the artist, and each artistic piece has a unique fingerprint artistically and scientifically. With technology we can re-engineer the artistic process and unfold the hidden secrets of artifacts and give more insights into the artist's style.

Whether it is an oil painting or a manuscript, wall painting or a miniature, the investigation of artifacts is not limited to the surface information but it goes beyond the visible reflections into the multi-layered information and strata.

This research will present the documentation, the investigation process and the interpretation of the results of two kinds of artworks; oil paintings and manuscripts as well as the presentation of few case studies of modern and contemporary paintings in addition to a Holy Quran manuscript. The research will introduce several approaches and techniques; contextual and historical studies, visual inspections, spectroscopic measurements, photographic recording, ultra-high resolution digitization and multi-spectral imaging. Analysis of the results has shown that using these techniques gave us the possibility to study the surface and the strata which revealed several findings and layers of information that indicated in some cases clear shift of the original composition. The results will allow the tracking of any conservation attempts, recovery of faded colors and signatures in addition to studying the artist's technique. This stack of results can be used as a fingerprint of each original artwork which introduces to researchers, restorers, curators and art lovers the opportunity to access and study the artifacts with different layers of information to achieve better understanding of the artworks.

KEYWORDS: Multispectral Imaging, Archeometry, Composition Shifts, Art and Science.

INTRODUCTION

People have different ways and perceptions when they take a look at any scene, same like looking into a piece of art. In an attempt to have a better understanding of artworks, both artistic and scientific interpretations are feasible. Artistically, we can speak about the style, the history, the colors, the concept and the messages that it holds, to the rest of the artistic aspects. Scientifically, the artwork is viewed as ancient and modern formulas of chemical and physical factors that construct a final work.

As a result of the enormous amount of artistic production that has been done, nowadays people hold huge legacy of artistic production with a wide diversity of classifications

whether from ancient times or produced in modern times. Specialists from many disciplines are increasingly conducting not only the contextual, historical and material studies on a specific artwork but also the interaction between the artwork and different elements. Technological techniques in the examination and investigation of artworks became a pressing need and may be inevitably important in understanding certain aspects of the examined artefacts.

The scientific approach to art and archaeology commenced around 1780 and since then, science and technology are continuously providing new methods and techniques for the documentation and investigation of artworks. All the scientific applications for the analysis and investigation of archaeological materials are becoming very important to be considered as a unique scientific field of its own which is known as Archaeological Science or Archeometry.

Advanced documentation and testing techniques utilize non-destructive, objective, and reliable scientific methods to discriminate between samples made from different materials. The combination of digital imaging and spectral analysis make it possible for the determination of chemical similarities and differences of pigments. The morphological characteristics of artifacts can be determined revealing any deformations or cracks of the paint layers in addition to the detection and monitoring of conservation treatments by the use of multispectral imaging. This important information can be used in integration as an identifier of the art object under study and in revealing fraudulent artworks.

The first step in a documentation or conservation project is to collect comprehensive knowledge about the object under study. Historical and contextual information can be conducted in parallel with several morphological and elemental examinations. To understand the artwork in a better way, more attention is paid not only to the surface but also to the strata. The surface information from colors and topographic information is digitized using many techniques; Ultra high resolution scanning (Ektessabi, 2008; Toque, 2010), detailed photography and multispectral imaging. The investigation results of Multispectral imaging are useful in the determination of color information as well as the attempt to use IR photography or reflectography and UV photography in the examination of any hidden layer or erased text (Verhoeven, 2008). IR photography is not as capable as the IR reflectography in penetrating into paint layers while IR and UV photography techniques are simpler in applications which they can be used to reveal hidden text, identifying of restoration attempts, faded signatures and any fraudulent attempts. These results can be considered as integral part of the information that has been collected and kept as a record for future use.

In this research several case studies will be presented to demonstrate the digitization and investigation of selected artworks and to shed some light on several technological techniques that can serve in the investigation, preservation and authentication of artworks and to give a deeper perception of artworks under study.

Methodology

The framework for artwork investigation (El-Rifai et al., 2013) includes multidisciplinary studies of the artistic, historical and technical aspects of the artwork. Thus, the research will focus on the technical studies that reveal the under layers or the under drawings of the artwork (Boer, 1968) whether it is an oil painting which has relatively thick paint layers or a thin paper of a manuscript.

- **Contextual Information**

This step is important for collecting relevant information about the artist and the history of the artwork in addition to a preliminary condition assessment.

- **Digitization and Physical Data Acquisition**

Speaking of this stage the focus is directed towards the surface as well as the strata. Firstly, the surface colors, topography and microstructure are collected. Followed by the acquisition of spectral properties of different materials and concluded by the extraction of the multi-layered information of strata.

Moreover, the use of high resolution imaging accompanied by reference targets and the creation of master files are the initial steps in the digitization of artworks followed by the use of different bands of light for the acquisition of the visible, infrared and ultraviolet reflections. The use of different lighting conditions reveals different perceptions of objects. Parameters like; light conditions, object surface roughness, object colors, object materials and human vision characteristics also give different color perception. By capturing the different bands of light, the unique signatures of color and materials of the captured objects are recorded as well.

Raking light in addition is used to reveal the topography of the surface and any deformations or cracks of the paint layer by applying several incident light angles to the surface of the artefacts and taking different images then baking all together to form the topography.

- **Investigation and Analysis**

Post-processing can be made on the pixel level, region of interest or complete image layer to extract meaningful information.

Vector line documentation is one of the methods used in the investigation which is based on tracing the artwork to be converted to vector lines. The illustration of vector lines can be used as a map to identify several regions over the object which helps in the creation of a condition assessment report and the planning of conservation treatments.

Furthermore, imaging spectroscopy is based on the integration between digital imaging and spectral measurements which introduced a lot of advantages regarding pigments and colors. It gives the possibility of identifying pigments, tracking color changes and analyzing different materials in artworks.

- **Dissemination**

Several applications can be developed for the distribution of the investigation results to be available for researchers and for archival purposes.

Artwork Investigation Case Studies:

Case Study of Mustafa Shaker Holy Quran Manuscript;

- **Contextual and historical information**

Located in the galleria of the Center for Documentation of Cultural and Natural Heritage (CULTNAT). The manuscript is a Book of Holly Quran hand written which is written by the Amiralay Mustafa Bey Shaker (Interview with Sallama Shaker in 2010). It has a cover that is decorated with flowers and other fine ornaments Fig (1). The first two pages are well ornamented as well Fig (2, 3). The dimension of the manuscript is 14cm in width and the height is 22.5cm. It consists of 260 pages. Each 4 folios are sewn together with a string. The gatherings and some folios are loose from binding, it is also noticed that there is a previous attempt of minor consolidation.

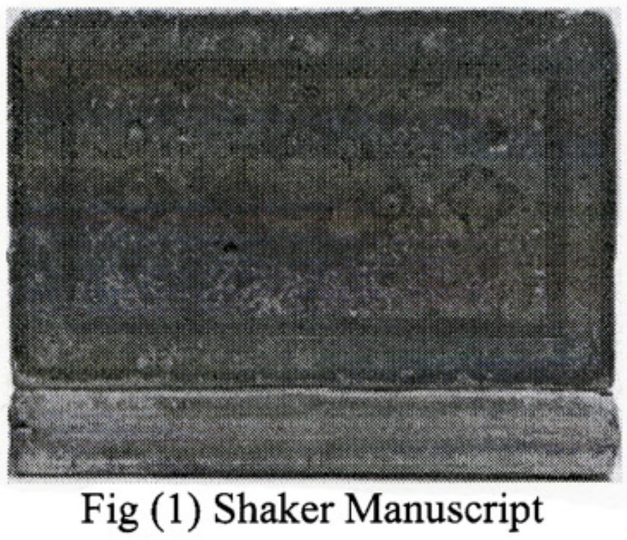


Fig (1) Shaker Manuscript

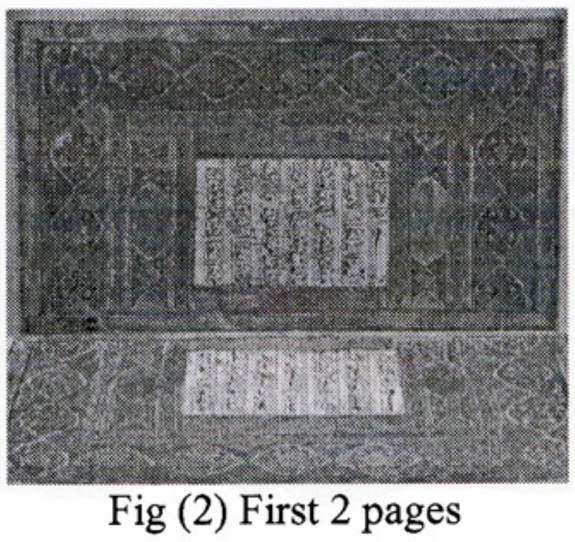


Fig (2) First 2 pages

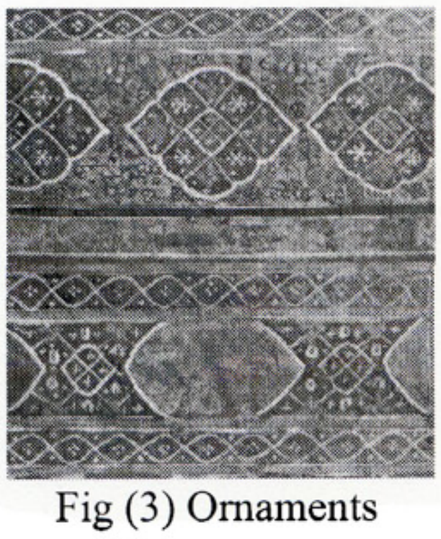


Fig (3) Ornaments

Shaker originated in Russia among several Muslim trips. When the war started between Russia and Ottoman Empire, Muslim tribes had to relocate. Amiralay Shaker settled in Egypt in 1885 where Sultan Abdel Hamid agreed to send him to Egypt as an honorary consul of the Ottoman Empire and as an officer for Halfa and Aswan. This period was very important for him as he started to learn Arabic and manuscript writing, he started to write version of the holy Quran. According to an interview with his granddaughter; the manuscript is written approximately between late 1800 to the beginning of 1900.

The manuscript has 15 lines per page for Arabic text; each line is followed by ottoman language translation, except for the first two pages which appears that the ottoman translation is wiped out Fig (4). On the first 6 pages the text was framed with double black thin horizontal lines over and under the Arabic text as guidelines to leave an approximate 1cm for the Arabic and 0.5cm for ottoman Fig (5). This arrangement was abandoned from the author in the rest of the book as text guidelines were hidden which may indicate that he preferred a less visual disturbance. Corrections of the mistakenly written or missing words have been amended on the sides of the page Fig (6).

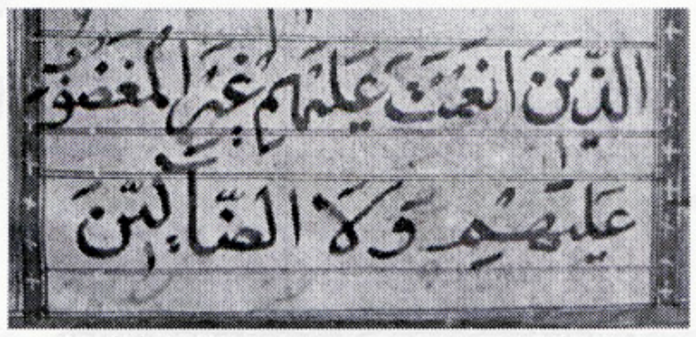


Fig (4) Missing ottoman translation

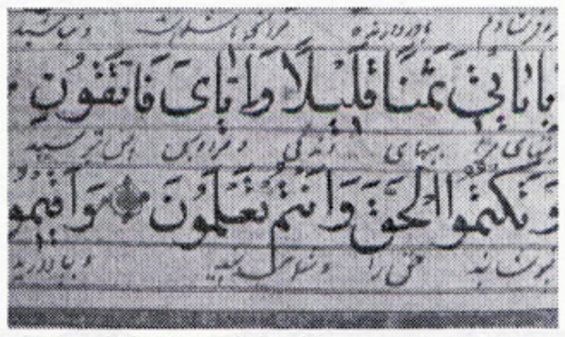


Fig (5) Double line separator

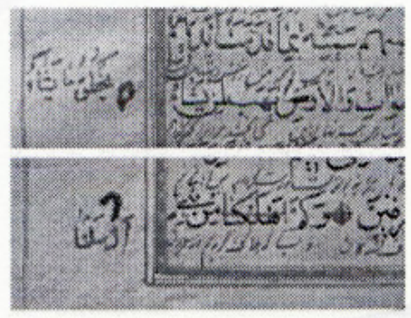


Fig (6) Text corrections

- **Digitization and analysis**

The digitization of the manuscript has been conducted using detailed photography to record the main elements that describe the manuscript including the cover, binder, paper, ink, ornaments, text ... etc. Digital and Microscopic investigations identified that the paper is laid paper with clear chain lines. Text has been written with black and red inks Fig (7) while black, blue and golden lines have been used for borders Fig (8). The ornamented verses separators are composed of two crossed red lines over a golden circle and four blue dots at each end of the red lines Fig (9).

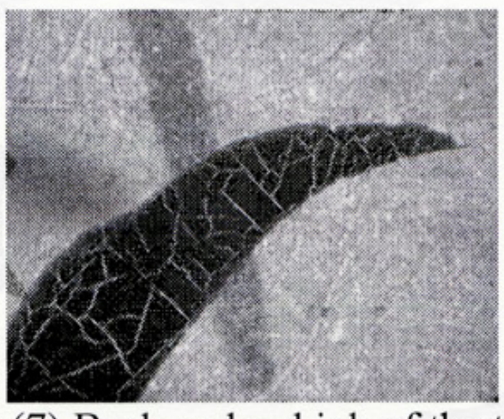


Fig (7) Back and red ink of the text


Fig (8) Border lines

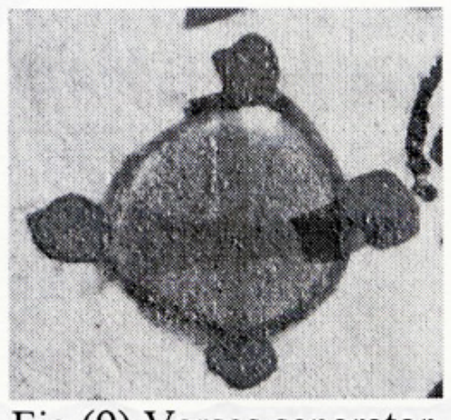


Fig (9) Verses separator

The dating of the manuscript can rely on the identification of the watermarks, the manufacturer, paper size and quality. The verso and recto investigation of the pages identified that the manuscript is written on laid European paper with visible chain lines every 2.3, 2.7 and 3cm. Papers hold watermarks with text "ALMASSO and GIOVANNI CHECCHI" Fig (10), "GM" in the few pages Fig (11) and "POLLERA" Fig (12).

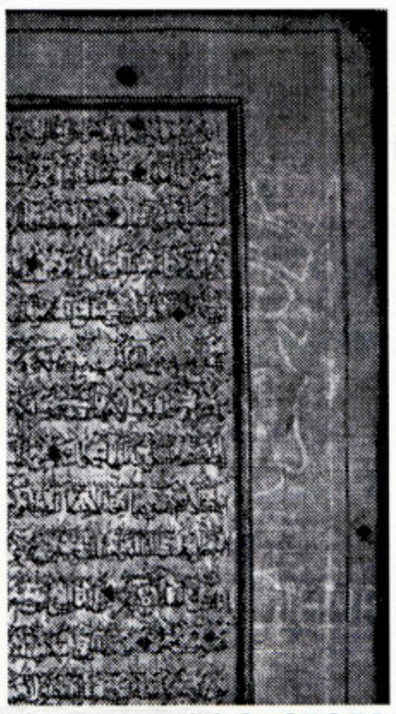


Fig (10) ALMASSO GIOVANNI CHECCHI watermark

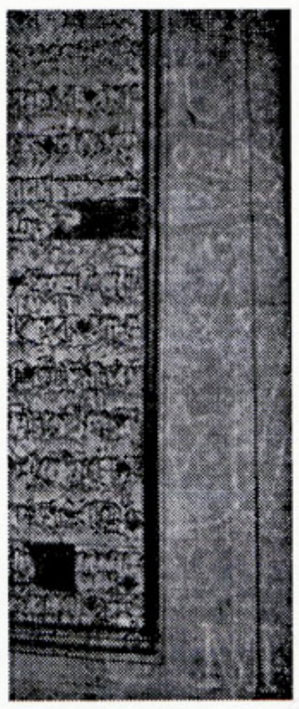


Fig (11) GM watermark

Fig (12) POLLERA watermark

Multispectral imaging has been used for the investigation of any traces of erased text, watermarks, fingerprints, investigation of colors and ornaments. Imaging with infrared reflected and transmitted radiation as well as ultraviolet florescence identified traces of Al-Fatha Sura Fig (13) which was written then erased on the first page Fig (14) of the manuscript. The revealed text has been redrawn for better visualization Fig (15). This along with the slight variation in the style of writing and the changes of the paper gave us more insights into the accumulation process of the writing of the manuscript. Also it confirmed the story that has been told about the author from his granddaughter on the efforts that he undertook to write this copy of the Holy Quran while still learning the art of calligraphy and manuscript writing.

Fig (13) Empty page at the start

Fig (14) Traces of Al-Fatha on the empty page

Fig (15) vector line tracing of part of the erased text – Al-Fatha

Case Study of oil paintings;

In this section we will present a few cases for the documentation and investigation of oil paintings that belongs to different artists. Starting with the collection of the contextual and historical information, then the digitization and analysis of the surface as well as the strata.

- **Contextual and historical information**

The first painting Fig (16) belongs to *Hosni Mohamed El-Bannani* (1912-1988) (Ministry of Culture, 2010) an Egyptian impressionist that enjoyed the simplicity of expression while taking care of fine details; he introduced the Egyptian countryside in a special localized impressionism.

Secondly, a presentation of two paintings Fig (17) and Fig (18) by *Samir Rafeaa Mohamed* (1926-2004) (Ministry of Culture, 2012) who was an Egyptian artist belonged to the second generation of Egyptian pioneer artists. His works focused on the essence of the subject where diluting the superficial outer figures to reveal his innate expression and abstraction creativity. Rafeaa has works that show the influence of realism, impressionism, surrealism, symbolism and abstractionism. Some of his Artworks will be subject to digitization and technical examination.

And finally a painting Fig (19) by *Abdelrazek Okasha* - born in 1968 - (Ministry of Culture, 2013) who is a prominent Egyptian-French Artist, critic and a board member of the Autumn Salon. Okasha is an active emerging contemporary artist who is concerned with building channels between European and Arabic culture through Art.

The three artists; Bannani, Rafeaa and Okasha may have some similarities and differences and regardless of the time span between them, they defiantly have completely different fingerprints. The examination of their artworks may expand our perception and understanding of the artists' style and technique.

Fig (16) Hosni El-Bannani 1936

Fig (17) Samir Rafea 1966

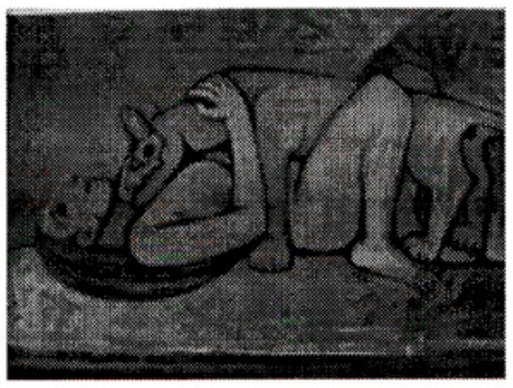


Fig (18) Samir Rafea 1973

Fig (19) Abdelrazek Okasha

- **Digitization and Analysis**

Multi-layered information has been acquired from the several paintings. The process began with high resolution photography in addition to the spectral measurement of several points that represent unique pigments from the surface of the paintings; these spectra along with the digital record of the paintings are archived in a designated database. Raking light photography has been used to extract the topography of the paintings and to reveal any damage. Multispectral imaging in the visible, infrared and ultraviolet regions constructed important information that revealed in some paintings clear composition shift that was recorded and mapped by vector line tracing.

Hosni El-Bannani Painting

Since the painting was suffering from many deterioration aspects, a conservation project has been conducted. Thus, several examinations had to be completed before the start of any treatment. The documentation processes had to go along with each step of the conservation treatments to record the painting condition Fig (20) before, while and after treatment.

High resolution scanning Fig (21), optical microscopy Fig (22) used to record and assess the surface, paint and canvas. The microstructures of pigments as well as the fibers of the canvas were examined by scanning electron microscope Fig (23). Other elemental analyses were conducted to extract the chemical composition of the materials to support the conservation decisions.

Multispectral imaging Fig (24) in particular has been used to investigate the surface and the strata of the painting. The post-processing of the Infrared imaging indicated a clear composition shift. El-Bannani changed the source of light which was from a lantern on the upper right corner of the painting, this is apparent on the villager figure and the direction of shadows and light on his face. In addition to other changes which can be found all over the painting.

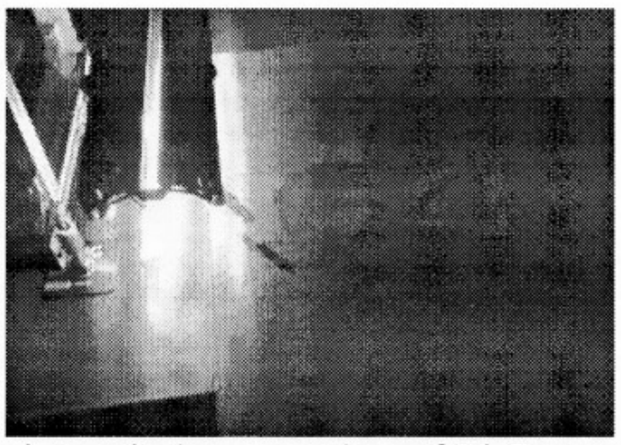


Fig (21) High resolution scanning of El-Bannani Painting (Ektessabi, 2008; Toque, 2010)

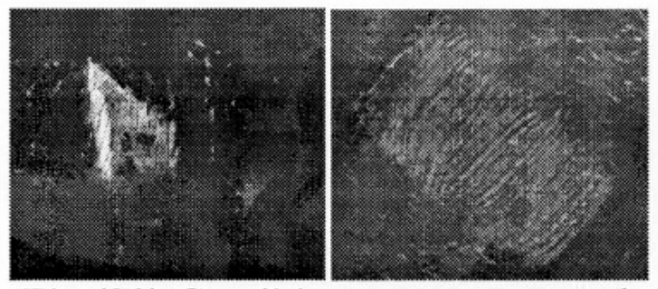


Fig (20) Condition assessment and brush stroke details

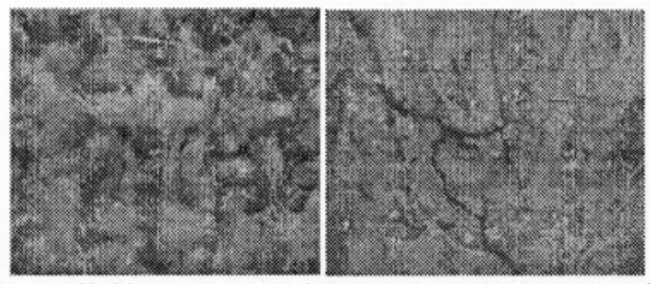


Fig (22) stereo microscope images of pigments and canvas structure

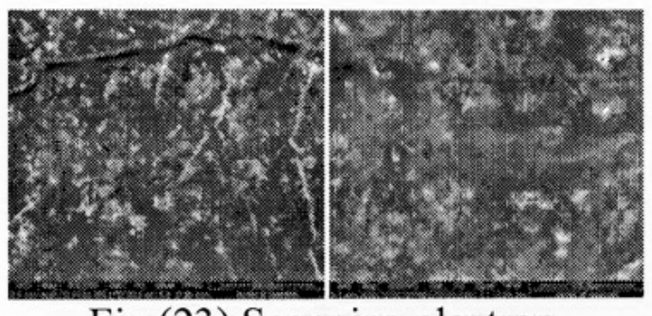
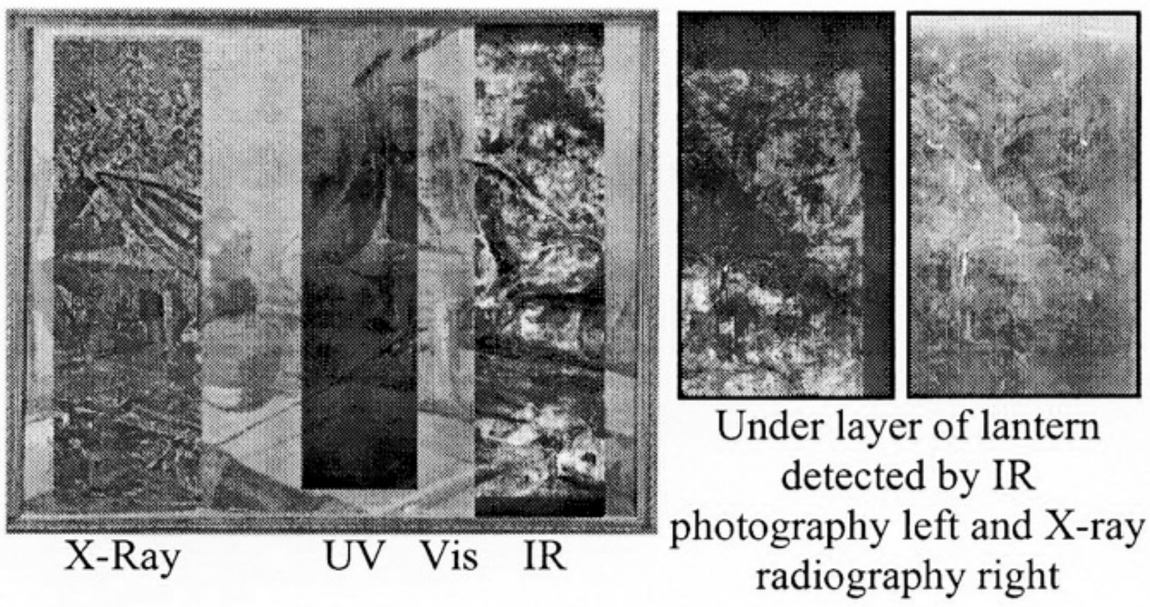


Fig (23) Scanning electron microscope images of pigments



Under layer of lantern detected by IR photography left and X-ray radiography right

Fig (24) X-Ray radiography, UV-Vis-IR imaging

Samir Rafea Paintings

The acquisition of highly detailed, color accurate and metadata described images is a systematic approach. Followed by spectrometric measurement for the spectral reflectance of unique pigments Fig (25, 28) that represents the full color palette of the painting (Zhao et al., 2008). The topography of the painting is recorded by raking light technique Fig (26, 29) to record not only the paint formation but also any surface deformation or cracks. The result of the multispectral imaging Fig (27, 30) revealed few corrections in the composition which have been separated by comparing different layers and the use of vector line tracing to highlight the differences Fig (31).

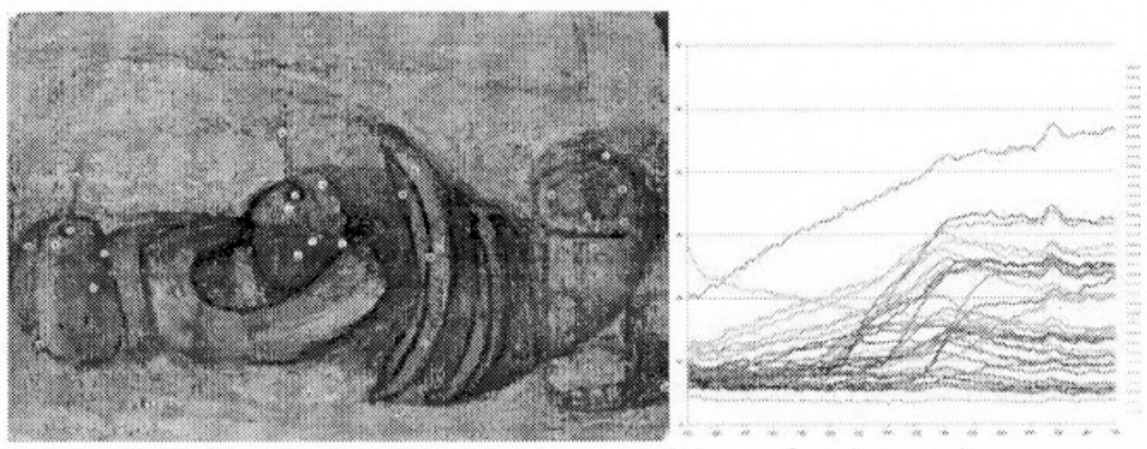


Fig (25) Spectral reflectance acquisition of unique pigments

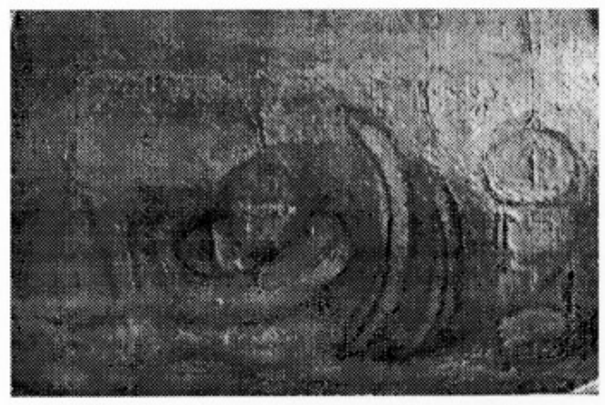


Fig (26) Topography of the surface By Raking light

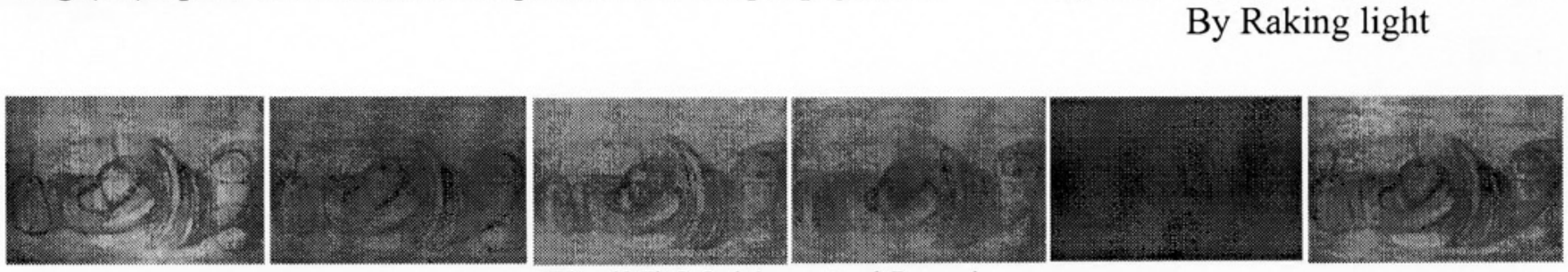


Fig (27) Multispectral Imaging

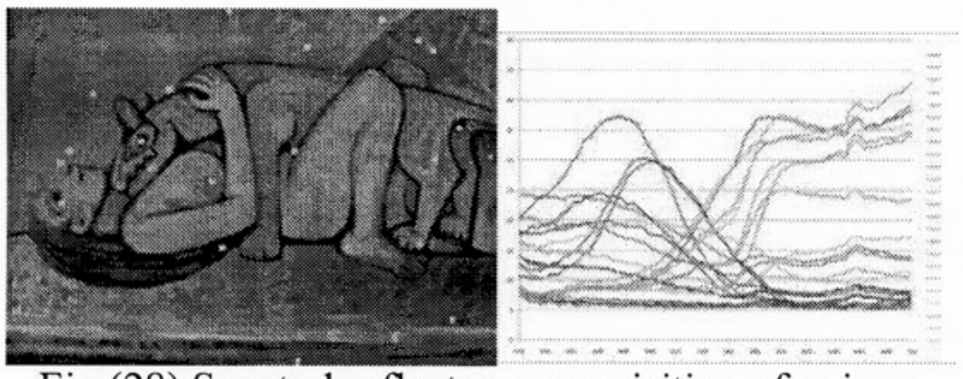


Fig (28) Spectral reflectance acquisition of unique pigments

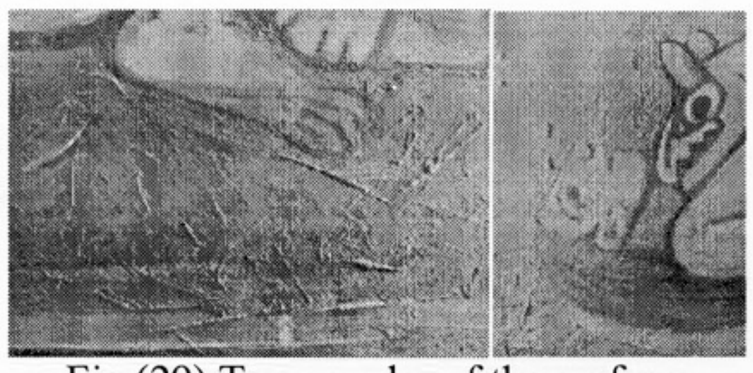


Fig (29) Topography of the surface By Raking light

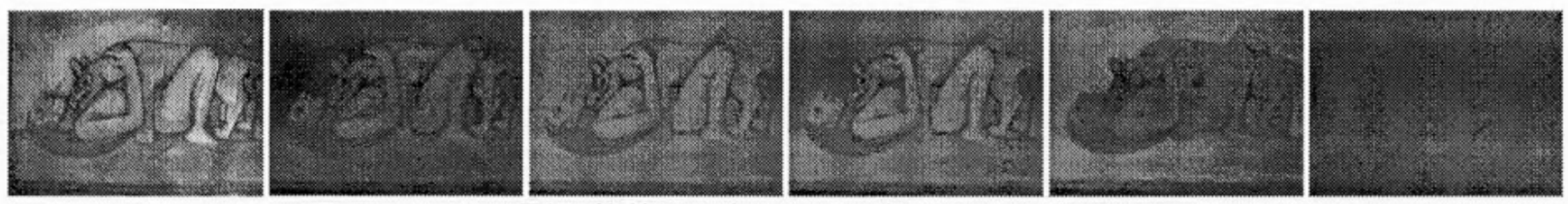


Fig (30) Multispectral Imaging

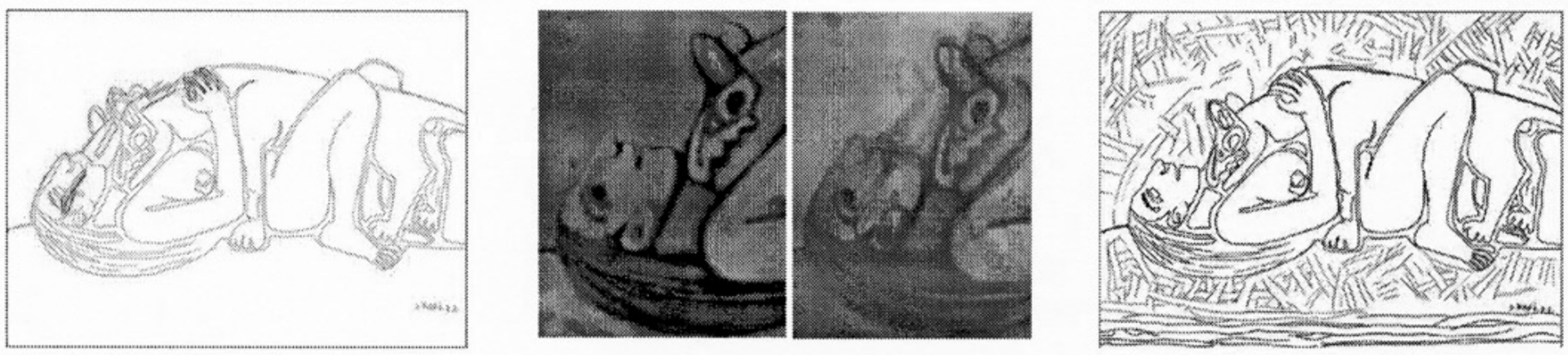


Fig (31) Vector line tracing and detection of composition shift

Abdelrazek Okasha Painting

As every artist, Okasha has his own unique touch and fingerprint, many of his artworks are created with rich thick paint layers to give depth and dimension and to convey his impression and his philosophy. One of his oil paintings is digitized by the use of high resolution imaging; including the mapping of surface topography of the painting by raking light Fig (32), followed by spectral reflectance acquisition of unique pigments Fig (33) and multispectral imaging recorded the different bands reflections.

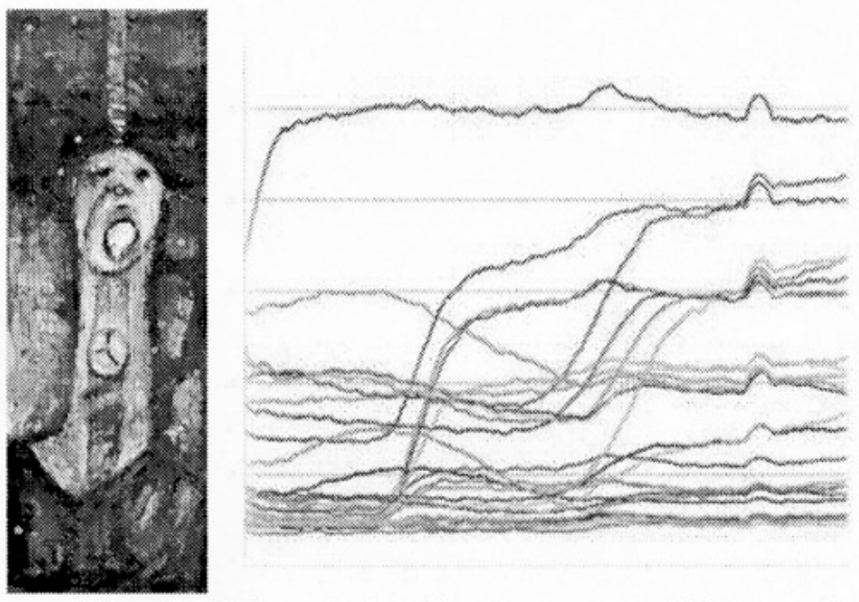


Fig (33) Spectral reflectance acquisition of unique pigments

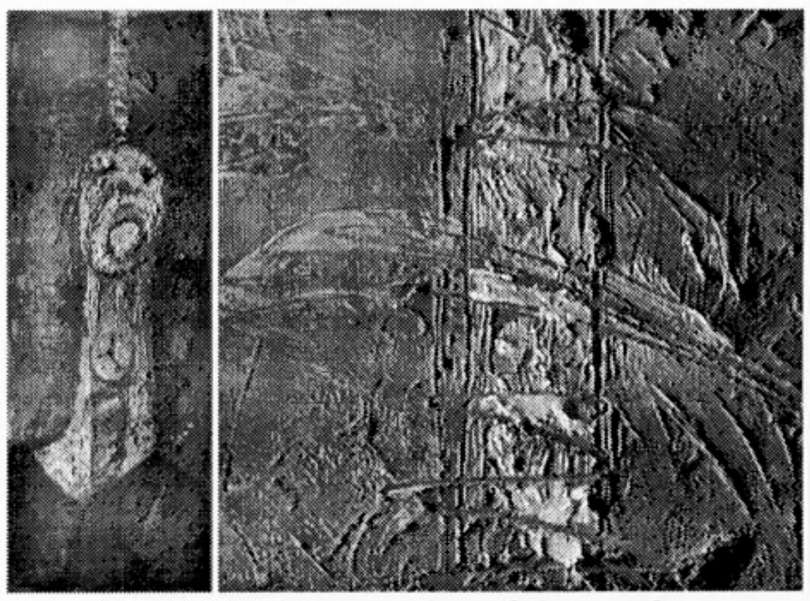


Fig (32) Topography of the surface By Raking light

Conclusion and Further Work

Different artworks have been presented which are separated by wide or narrow time span. A manuscript which carries a long story, the writer or artist had a long journey between countries and cultures then landed in Egypt to start writing a copy of the holy Quran. Each page and each line can tell us a story and reveal a hidden secret of the artefact while taking us one step nearer to the artist. Now we have a record of his learning process, his common mistakes and corrections, the papers that were used, the pigments that were available, his precision and dedication, even his fingerprint that was left on the corners of the pages. His legacy has been carried by his family and his story is being revealed by the scientific probe.

No surprise to find other Artists from different artistic fields even from different time span would have common practices as Amiralay shaker. El-Bannani enjoyed changing his composition (Gazalah, 2007) and light sources while keeping track of simplicity and authenticity. But, if it has been possible to see through some artworks by a scientific eye, it requires more trained artistic eye to go through Rafae's artworks. Even so, technology can dismantle the artwork and makes it ready to be digested by art historians and art lovers.

It is not about searching for under layers or searching of hidden messages by paint layers, sometimes the secret is on the surface and on the thick layers of paint that makes the artwork speaks of its wonders as in the case of Okasha.

In this research several artefacts have been presented as case studies to demonstrate the documentation and investigation processes of artworks. Due attention has been paid to the digitization and investigation using multispectral imaging. The results of the investigation introduced several findings; composition shift, erased text, identifying watermarks and supporting historical studies.

Each artefact has a unique signature which can be deciphered artistically and scientifically. The scientific approach to art and archaeology introduced several technological means for the documentation and investigation of artworks which produces hidden information that can support the contextual and historical knowledge about the artefacts. This information can play an important role in future studies, preservation procedures, conservation treatments and giving deeper insights to the understanding of the artistic values of the artwork and the artist as well.

To complete the stack of information that is needed, elemental analysis should be conducted for the different pigments as well as the support.

The spirit of an artist is revealed in his work. Technology can hunt the traces that they leave behind to be recorded and investigated, the sum of all these contextual, historical, archival and elemental analysis can work as a fingerprint and identifier of each artwork and artist.

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