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**The colors used in the mural painting of Roman houses in the oases  
of Dakhla and Kharga**

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**Abstract**

The Roman artist excelled in painting on house walls, where wall painting formed an integral part of house architecture. It expressed the personality of the resident, their religion, social status, and daily lifestyle. And each time period left a distinct mark that differs from other periods in all its details, and this was evident in the colors. After the dominance of Egyptian blue in previous ancient eras in specific locations, this prosperity diminished during the reign of the Roman Empire.

The colors used in the paintings varied, and we can imagine that in each region, people began to discover the resources of their region and their components. They attempted to produce materials suitable for coloring, and these materials evolved within the same region over time. Some were renewed, and the best of them discovered the superior ones.

We will know on about the sources of these colors on these pages.

**Keywords:** mural, painting, Red, Blue, Green, Yellow, Black, White.

**Introduction:**

The Roman artist excelled in painting on house walls, where wall painting formed an integral part of house architecture. It expressed the personality of the resident, their religion, social status, and daily lifestyle. The city of Pompeii stands as the greatest witness to this, thanks to the eruption of Mount Vesuvius, which froze time for its inhabitants. However, with continuous discoveries, many Roman cities have come to light, although their houses do not constitute more than a single line in the newspaper of Pompeii's houses. Among these cities are the city of Amheida and the cement houses located in the Dakhla Oasis in Egypt, as well as the city of Douch located in the Kharga Oasis in Egypt.

The components of the colors used in the paintings are diverse, and we can imagine that in each region, people began to discover the resources of their region and their components. They attempted to produce materials suitable for coloring, and these materials evolved within the same region over time. Some were renewed, and the best of them discovered the superior ones.

**Importance of research:**

The importance of research lies in the need to understand the composition of the colors used during the Roman period. In the houses of the Italian city of Pompeii, vessels were found that still retained ready-to-use pigments. This led us to investigate the composition of the colors used in the oasis houses, based on the differences in the environment and the soil that significantly contributed to the formation of colors.

**Problems of research:**

From here, the research raises several questions, such as: Were the nature of the materials used in a particular color consistent or did it vary depending on the homeowner? Did the materials used in colors correspond in different regions of the empire? Or did the oasis soil play a specific role in the composition? What were the most common colors during this period? And which were the least common? What did these colors symbolize and signify?

**The Methodology:**

In the research, the researcher followed the analytical approach based on previous studies to reach the components of colors from the elements involved in their composition, in addition to knowing their symbolism and connotations in different depictions during successive periods and eras.

The remains of the three cities are limited to the remnants of buildings, some of which were excavated, documented, and then reburied, only to be uncovered by the winds for years and reburied by sand for another few years. We will mention each city in some detail separately.

In the **Amheida** city, there is the house of Serenos, dating back to the end of the third century and the beginning of the fourth century AD. After the excavation was completed, the American mission led by Roger Bagnall reconstructed an exact replica of the villa on the outskirts of the archaeological site. The colors of the house will be studied based on the replicated house. The house contained several richly decorated rooms, including the main room, which was a meeting room with both mythological and everyday life scenes depicted, including a depiction of the

owner and his family at a banquet. There was also a room called the Red Room, as the majority of its depictions were in red color with simple color interferences, and another room called the Green Room for the same reason. The last room depicted repeated motifs with slight variations, dominated by the color purple.

As for the city of **Ismant el-Kharab**, which dates back to the same period as the Amheida city and is not far from it, excavations revealed several decorated houses with mural paintings, some of which were documented. These houses contained intricate geometric designs with rich diverse colors. In the city now, remnants of ceilings and walls can be seen with traces of white plaster and scattered colors.

In the city of **Douch**, located in the Al-Kharga Oasis, a room was discovered in a house near the Douch Temple, dating back to the late third century AD. Two walls in the room were painted, while the other two walls were coated with white plaster in preparation for painting. On the painted walls, there are depicted standing figures that are not clear due to the loss of the upper part of the wall.

Several colors were used in the mentioned house paintings to bring the drawings to life, including:

**The color red and its shades:**

Red color can be obtained from two organic and inorganic sources. The organic source is less commonly used due to its high cost. It is extracted from a

type of purple shellfish in the city of Tyre and is known as Tyrian Purple<sup>1</sup>. It was minimally used in mural paintings due<sup>2</sup> to its high cost<sup>3</sup>.

The second organic source is the madder plant (*Rubia tinctorum*) “έρυθροβδανον”<sup>4</sup>, also known as Madar. It is a dye plant, and the red color is extracted from its roots. It is known as Turkish Red<sup>5</sup>. The roots of the madder plant<sup>6</sup> were used in mural paintings during the Bronze Age, Hellenistic, and Roman periods because they were less expensive than other dyes. This material was found in Pompeii<sup>7</sup>, where a vessel for purple dye made from organic plant materials was discovered<sup>8</sup>.

As for the bright natural inorganic red, it is a mineral pigment derived from clayey red soil known as Ochre (hydrated iron oxide). It can be extracted from minerals such as cinnabar (mercury sulfide), realgar (arsenic sulfide), and various types of red iron oxide such as hematite after heat treatment and red ochre. Some types resulting from the mixing of hematite with Egyptian blue have been found<sup>9</sup>. Most red color analyses have shown that it is associated with red ochre as the main

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<sup>1</sup> Ruth Siddall, 2006, 25– 26

محمد محفل & محمد الزين, 2011, 176

<sup>2</sup> Maurizio Aceto, 2021, 11

<sup>3</sup> Ruth Siddall, 2006, 25– 26

<sup>4</sup> محمد إسماعيل, 2022, 29

<sup>5</sup> Basem Gehad, 2011, 18 ,And <https://www.marefa.org/%D8%A7%D9%84%D9%84%D9%83>

<sup>6</sup> <https://www.webexhibits.org/pigments/indiv/overview/madder.html>

<sup>7</sup> Maurizio Aceto, 2021, 5 –7

<sup>8</sup> Ruth Siddall, 2006, 24

<sup>9</sup> Ruth Siddall, 2006, 25–26

coloring element, which is a mineral form of iron oxide (hematite)<sup>10</sup>. The Western Desert soil in Egypt is a primary source of it due to its abundance of natural iron oxides<sup>11</sup>. Despite the diversity of red sources, iron is considered the main source. Dioscorides<sup>12</sup> mentioned that the best red ochre was brought from Egypt during the Hellenistic, Ptolemaic, and Roman periods<sup>13</sup>. Raw cinnabar has been found in a few paintings, and cinnabar mixed with hematite has also appeared to increase the quantity of this costly pigment and to give more brightness to red hematite<sup>14</sup>. Mercury, however, is mentioned very rarely<sup>15</sup>.

**Its symbolism:** The ancient Egyptians used the red ochre, which had an earthy red color, where it was considered one of the primary colors and took on the quality of the royal color, symbolizing victory<sup>16</sup>. The color red also symbolized violence, power, and the wars that lead to victory. It was also a symbol of deserts, the sun, gold<sup>17</sup>, and life<sup>18</sup>. It represented love, embodied by the goddess Aphrodite and Venus, thus indicating the contradiction between war and bloodshed on one hand

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<sup>10</sup> Graciela Gestoso Singer, 2010, 2.

And: Roxanne Radpour & Christian Fischer & and Ioanna Kakoulli, 2019, 9

<sup>11</sup> محمد إسماعيل, 2022, 29

<sup>12</sup> Dioscorides : was a Greek physician, pharmacologist, botanist, and author of De materia medica.

<sup>13</sup> Basem Gehad, 2011, 14

<sup>14</sup> Ruth Siddall, 2006, 24

<sup>15</sup> Basem Gehad, 2011, 14–15

<sup>16</sup> محمد إسماعيل, 2022, 15

<sup>17</sup> Mahda Foroughi & Shohreh Javadi, 2017, 71– 73 – 79

<sup>18</sup> According to Greek legend, the red rose originated from the blood of Adonis.

and love and strong emotions on the other. In ancient Egypt, men were depicted in red, as it was associated with health, illness, and strength and weakness<sup>19</sup>.

During the Roman period, wealthy aristocrats wore purple clothing due to its scarcity. Warriors also wore red to avoid showing blood when wounded<sup>20</sup>. The

availability of red color in paintings increased its importance and expanded its use in images after the Romans discovered multiple sources for it<sup>21</sup>.

The colors red and purple had a significant presence in the paintings of the studied houses. For example, in Serenos's house, there is a fully painted room in red, shape number (1). with simple color combinations for drawings. Another room is dominated by purple color with color combinations to form the drawings, shape number (2). In the meeting room of the house, parts of



Shape(1): The red room in Serenos house  
By the researcher



Shape(2): house of Serenos  
By the researcher

<sup>19</sup> Graciela Gestoso Singer, 2010, 8 –5

<sup>21</sup> Victoria Jewell, 2013, 14

<sup>20</sup> عزيزة سعيد, التصوير والزخارف الجصية ص 32 – 33

the geometric shapes on the wall were colored red and purple. The most prominent figure in the paintings throughout the city is Lady Amheida, wearing a purple cloak, dominated by purple color with color combinations to form the drawings, shape number (3), and most of the characters in the paintings are purple, in addition to the frames and many details in all the house's paintings. As we mentioned, the abundance of its use during this period was due to prosperity and luxury, and this is evident in Serenos's house. Even the writings found in the room near the surroundings of Serenos's house were in red color.

In the **Ismant el-Kharab** as well, red and its shades were extensively used.

We can observe its use as a uniform color for the background in the depiction of Serapis.

And in the city of Douch, it was also used as a primary color in the robes of all depicted characters.

### **Blue:**

One of the most famous colors, especially Egyptian blue, is the oldest known synthetic pigment dating back to the 4th millennium BCE<sup>22</sup>. It continued to be produced in Alexandria until the 1st century BCE during



Shape(3): Amheida city Lady  
By the researcher

<sup>22</sup> Roxanne Radpour & Christian Fischer, and Ioanna Kakoulli, 2019, 13



the Roman Empire<sup>23</sup>. It was known as<sup>24</sup> "Fritta", It is considered one of the most used pigments in ancient Egypt, composed of copper silicates through the calcination of copper, calcium carbonate (limestone or shells), and silica (quartz sand)<sup>25</sup>. It is then formed into balls that are exposed to furnace heat and then ground<sup>26</sup>. The expensive natural blue, known as "Armenian blue"<sup>27</sup>, was obtained from azurite, scythium, and lazurite. Vitruvius and Pliny mentioned that blue was obtained from the natural mineral of copper carbonate, azurite, but it was relatively pale<sup>28</sup>. Egyptian blue was mixed with different colors to give it a radiant effect. It was mixed with green, hematite, black, and others<sup>29</sup>. Egyptian blue was also referred to as synthetic lazurite because it is a synthetic composition of copper silicates, calcium, silica, and lime<sup>30</sup>. This pigment was found on pottery in Pompeii, indicating its potential use in its pure form<sup>31</sup>. There are other sources of blue pigments, such as lazurite (ultramarine), but this type did not spread significantly

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<sup>23</sup> Ruth Siddall, 2006, 25. And: Graciela Gestoso Singer, 2010, 2

<sup>24</sup> Irene Bragantini & Valeria Sampaolo, 2013, 100

<sup>25</sup> Ruth Siddall, 2006, p25. And: Graciela Gestoso Singer, 2010, p2

<sup>26</sup> Irene Bragantini & Valeria Sampaolo, 2013, p100

<sup>27</sup> Pliny called it Lapis armenium: It is an Armenian blue stone relative to the country of Armenia.

<sup>28</sup> Jehane Ragai, 1986, p77

<sup>29</sup> Roxanne Radpour & Christian Fischer & and Ioanna Kakoulli, 2019, p 12– 13

<sup>30</sup> محمد إسماعيل, 2022, ص11

<sup>31</sup> Ruth Siddall, 2006, p25.

before the 6th century AD. There is also a synthetic derivative pigment from a plant<sup>32</sup> that produces a blue color<sup>33</sup>.

**Symbolism:** The color blue had distinct significance in ancient Egypt, where it symbolized the Nile, from which Egypt derived its life. Hence, Egyptian blue was associated with the Nile, and that's why the god Hapy, the god of the Nile, was depicted in blue. Additionally, the blue color of the sky was associated with it<sup>34</sup>. The skin color of the Egyptian god Amun was depicted as blue to symbolize his role in the creation of the world. Some pharaohs were depicted with blue faces. Various deities were sometimes depicted with blue bodies, such as Ptah, Horus, Khnum, and Nut<sup>35</sup>. The status of this color rose to become the color of the gods, and wearing it was believed to provide protection. This is evident in lapis lazuli jewelry, which gives greater importance to both the jewelry



Shape(4): The walls of a room from of the city of Ismant el-Kharab have been documented and rebackfilled  
Eva Subías & Pedro Azara & Jesús Carruesco & Ignacio Fiz and Rosa Cuesta, 2011, 87.

<sup>32</sup> Indigo: a tropical plant of the pea family, which was formerly widely cultivated as a source of dark blue dye. For more: <https://www.marefa.org/%D9%86%D9%8A%D9%84%D8%A9>

<sup>33</sup> Ruth Siddall, 2006, p25.

<sup>34</sup> Mahda Foroughi & Shohreh Javadi, 2017, p 71– 74– 79

<sup>35</sup> Graciela Gestoso Singer, 2010, p13

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and the color, increasing the sanctity of the stone<sup>36</sup>.

However, during the Roman period, the use of this color diminished and became more associated with the East and barbarians<sup>37</sup>. This is evident in our paintings, where it was limited to simple details in Serenos's house, and its prominence is more apparent in shape number (4).

**Green:**

It is manufactured from Malachite (natural copper ore), which is considered the finest source of this color<sup>38</sup>, or from green earth or copper carbonates resulting from the corrosion of copper in acidic environments. Malachite was found in dye vessels in Pompeii. Green is often the result of a mixture of Egyptian blue and yellow ocher. Sometimes green earth is taken and a little Egyptian blue is added to give it more brightness. However, the most commonly used material for green is pure green earth, which is divided into two types based on the soil components. The first type contains Glauconite and is concentrated in marine sediments, while the second type is Celadonite, produced from volcanic rocks. However, it is generally referred to as green earth<sup>39</sup>. The pigment "Celadonite" was found in various paintings in pure or mixed form, and Cyprus is known for its deposits of this mineral<sup>40</sup>.

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<sup>36</sup> Jehane Ragai, 1986, p76

<sup>37</sup> Victoria Jewell, 2013, p14

<sup>38</sup> Irene Bragantini & Valeria Sampaolo, 2013, p100

<sup>39</sup> Ruth Siddall, 2006, p26

<sup>40</sup> Roxanne Radpour & Christian Fischer & and Ioanna Kakoulli, 2019, p13

**Symbolism:** Green is a common color for farmers' clothing, along with brown and gray, as they are cheaper colors, although some prefer white<sup>41</sup>. Green represents trees, agriculture, and fertility, which give hope, optimism, and lead to prosperity, rejuvenation, and vitality. This is why green symbolizes new birth and success, represented by the victory of spring over the barren winter<sup>42</sup>.

We notice the presence of green in many places. For example, there is a green room in Serenos' house in shape number (5), and another room in the city of Ismant el-Kharab. Green may have been the third most used color after red and white. Its use in non-geometric images is simple and natural.



Shape(5): house of Serenos  
By the researcher

<sup>41</sup> عزيزة سعيد, التصوير والزخارف الجصية ص 32-33

<sup>42</sup> Graciela Gestoso Singer, 2010, 4. And: Mahda Foroughi & Shohreh Javadi & 2017, 72- 79

**Yellow:**

Yellow has several sources. It is composed of a mixture of Orpiment<sup>43</sup> and Realgar<sup>44</sup> to form Arsenic Trisulfide ( $As_2S_3$ ), which is considered one of the highest-quality yellow pigments<sup>45</sup>. Orpiment was found in Pompeii paintings<sup>46</sup>. Yellow color is also found in some archaeological pieces composed of a type of iron oxide called Ilmenite ( $FeTiO_3$ )<sup>47</sup>.

The color known as yellow also includes Realgar, which consists of Geothite mineral, silica, and child minerals. It is often mixed with calcite, quartz, and clay, which gives it a more brownish color<sup>48</sup>.



By the researcher: Mount Abu Tartour

<sup>43</sup> Orpiment: a bright yellow mineral consisting of arsenic trisulfide.

For more: Basem Gehad, 2011, p17

<sup>44</sup> Realgar: a soft reddish mineral consisting of arsenic sulfide, formerly used as a pigment and in fireworks. For more: Basem Gehad, 2011, p17

<sup>45</sup> Basem Gehad, 2011, p17. And: Graciela Gestoso Singer, 2010, p12

<sup>46</sup> Ruth Siddall, 2006, p27

<sup>47</sup> Basem Gehad, 2011, p17

<sup>48</sup> محمد إسماعيل, 2022, ص17

Yellow ocher, or "Le ocre"<sup>49</sup>, was also used Iron hydroxide for yellow<sup>50</sup>. Yellow ocher is found in natural sandy rocks in the Western Desert, specifically in the iron mines in the coastal oases. In the Eastern Desert, it forms a cover rock, but it turns into red when exposed to high temperatures, transforming from hydrated iron oxides (limonite) to anhydrous iron oxides (hematite)<sup>51</sup>.

Yellow was also made from Lead Oxide, which was found in Roman villa paintings in France<sup>52</sup>.

**Symbolism:** Yellow was a common dye for ordinary people<sup>53</sup>, as the close proximity of red and yellow due to natural factors led to the transformation of yellow into a dark yellow close to red. This led the ancient Egyptians to mix them. The sun and gold sometimes took on a reddish color, while in other places, yellow symbolized immortality and continuity. However, it was believed that the skin and bones of the gods were yellow and golden<sup>54</sup>.

Golden yellow was used in simple details, but it played a role in displaying wealth, appearing like gilding on the edges of Douch's garments. It was also used in geometric patterns in Serenos' house, and the yellow color was used as the background behind Perseus and Andromeda to depict the sandy desert nature of the oasis. Its presence in the rest of the images was light but highly effective, as

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<sup>49</sup> Graciela Gestoso Singer, 2010, 2 – 12

<sup>50</sup> Ruth Siddall, 2006, p27

<sup>51</sup> محمد إسماعيل, 2022, 17

<sup>52</sup> Ruth Siddall, 2006, 27

<sup>53</sup> عزيزة سعيد, التصوير والزخارف الجصية ص 32 – 33

<sup>54</sup> Mahda Foroughi & Shohreh Javadi, 2017, 74– 79

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the artist used it to depict the richness in painting and the true purpose behind it. Its presence had a beautiful effect in the images in the city of Ismant el-Kharab

**The Black:**

Made from carbon compounds (soot, powdered coal, and animal bones)<sup>55</sup>, according to Pliny, the main source of black in various imperial places was soot, also known as "shihwar" or burnt bone charcoal<sup>56</sup>. It could also be derived from plant origins, resulting from the burning of resin or needle plants like pine, as well as from the trunk, root<sup>57</sup>, and bark of pine plants, and the burning of dried grapevine stalks known as "black of the grapevine."<sup>58</sup>

**Symbolism:** In some instances, Osiris, the god of the afterlife, took on the color black as a symbol of life after death. This vitality and activity were embodied by the appearance of daylight after the dark black night. The Egyptians also associated this concept with the observation of the black mud of the Nile after its flood, where the mud takes on a black color due to the greenish residues, and then the land

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<sup>55</sup> Graciela Gestoso Singer, 2010, 2

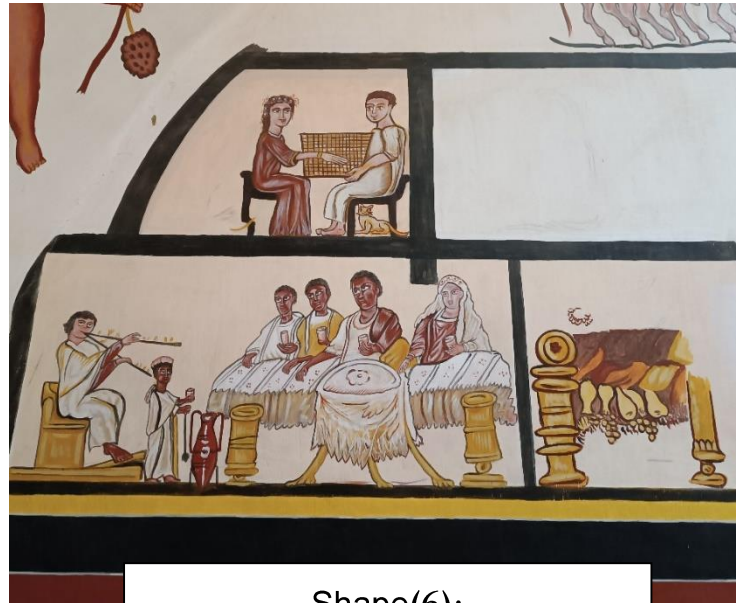
<sup>56</sup> Ruth Siddall, 2006, 28      And: Irene Bragantini & Valeria Sampaolo, 2013, 100

<sup>57</sup> Irene Bragantini & Valeria Sampaolo, 2013, 100

<sup>58</sup> Basem Gehad, 2011, 119

flourishes with agriculture, giving them a sense of energy and vitality associated with this color<sup>59</sup>.

The presence of black was scarce and quiet, often used for frames or specific drawings, such as figure number (6).



Shape(6):  
By the researcher

### **White:**

White is derived from several sources, including gypsum and calcium carbonates produced from limestone powder, chalk, mollusk shells or bird eggs<sup>60</sup>, and calcium sulfate. Industrially produced white lead carbonate was also used<sup>61</sup>, obtained by direct oxidation of white lead at 300 degrees Celsius. White lead was considered a primary source of white pigment during the Roman period<sup>62</sup>. In Pompeii, pure white lead carbonate was found, sometimes mixed with organic dyes, lime powder, and glass. Magnesium carbonate was also commonly used in white

<sup>59</sup> Mahda Foroughi & Shohreh Javadi, 2017, 72– 74– 79

<sup>60</sup> Ruth Siddall, 2006, 28. And: Basem Gehad, 2011, 119

<sup>61</sup> Jehane Ragai, 1986, 75

<sup>62</sup> Basem Gehad, 2011, 119



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pigments<sup>63</sup>. Calcium carbonate was known as "paritonio" and was primarily sourced from Egypt<sup>64</sup>.

**Symbolism:** The color white symbolizes rebirth and sanctity. This is evident in the white crown of Upper Egypt, which is actually made from green straw<sup>65</sup>. White is associated with purity, innocence, peace, joy, and it has been the color of the clothing of gods in several civilizations. The priests of Ur wore white, representing pure spirit and sacred life. This view extends to our present day, where white is worn during religious ceremonies and weddings<sup>66</sup>. White is the color of daylight, sunlight, the afterlife, holiness, purity, and clarity<sup>67</sup>.

In the house of Serenos, large areas of walls were painted with white gypsum, sometimes entire walls, to achieve maximum reflection of light inside the house. Additionally, some details were colored with white, particularly in the costumes of the characters depicted in the banquet scene of Serenos. This may have been to show the character of household clothing and the prevailing color of people in non-official celebrations, as white is less heat-absorbent, especially since the oases are among the regions with the highest temperatures, in shape number (6).

Roman painters excelled in color variation and innovation by mixing colors or adding white to lighten them. For example, when red was mixed with white, pink was produced. They also sometimes applied color in layers. For instance, they would

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<sup>63</sup> Ruth Siddall, 2006, 28. And: <https://www.marefa.org/%D8%A7%D9%84%D9%84%D9%83>

<sup>64</sup> Irene Bragantini & Valeria Sampaolo, 2013, 100

<sup>65</sup> Mahda Foroughi & Shohreh Javadi, 2017, 74

<sup>66</sup> Graciela Gestoso Singer, 2010, 8

<sup>67</sup> Mahda Foroughi & Shohreh Javadi, 2017, 79

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apply Egyptian blue over a layer of gray–blue to achieve a pale blue shade, or they would apply two layers of Egyptian blue to achieve a strong blue color<sup>68</sup>.

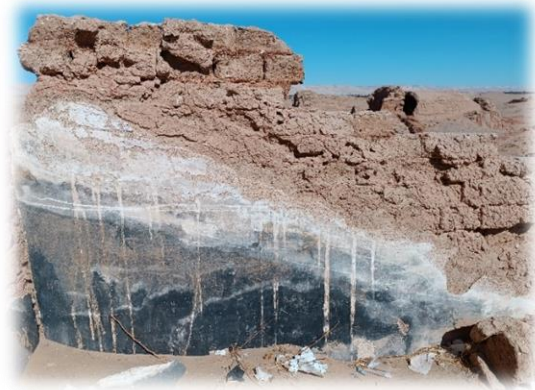
In terms of symbolism, we find that colors indicate the most famous associated mineral. When we see jewelry tinted with red or yellow, we can understand that the artist wanted to indicate the material of the jewelry, such as gold. When we see a vessel colored with silver tinged with blue or blue itself, we can understand that it is made of silver. This applies to other objects as well. When the artist colors clothes with purple–red, he may want to show the wealth, greatness, or strength of the depicted person, and so on.

The mentioned color analysis is further confirmed by a document dating back to the Roman period called "The Mappa of the Miliades." It includes a list of colors: carbon (smoky or burnt black ash), red lead or red lead oxide (sinapar), lead oxide, red earth, natural ultramarine blue, manufactured ultramarine blue, green copper carbonate (malachite), sodium carbonate, and copper oxides<sup>69</sup>.

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<sup>68</sup> Elizabeth Pye, 2000, p27

<sup>69</sup> محمد إسماعيل, 2022, 44 – 43



The current situation of the city  
of Ismant el-Kharab  
By the researcher

**Results:**

It is fascinating to note the distinction in the types of colors used to paint each element. For example, through our study, we discovered that the violet used in murals differs from the type of purple used in clothing dyeing, and so on. This distinction in the color material used appeared among the Greeks, Romans, and

those who came before and after them. Therefore, research continues on the types of color materials used in murals.

One of the observations we made in our study of paintings is the dominance of the color red and its widespread use in various shades. We noticed this especially in the house of Serenos and the houses city of Ismant el-Kharab, Even the writings found in Room 15 of Serenos' house were in red color, which constituted the majority. Other colors followed, and we found rooms in the Ismant el-Kharab where blue dominated, as well as others where green, like the green room in Serenos' house, was prominent. The rest of the colors followed their familiar and natural course of existence.

From this, we conclude that the flourishing use of the color red prevailed based on the beliefs surrounding this color during this period. The fertile soil of the oases, rich in iron oxides, also contributed to this, as did the other colors. We find that green was also easily obtainable and ranked second in abundance in the paintings after red. We cannot neglect white, which is the neutral color used with all other colors, both individually and collectively. Then comes blue and the rest of the colors.

**Conclusion:**

Each time period left a distinct mark that differs from other periods in all its details, and this was evident in the colors. After the dominance of Egyptian blue in previous ancient eras in specific locations, this prosperity diminished during the reign of the Roman Empire. Of course, the dominance of rule in a region and the availability of material for this color were factors that contributed to this.

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Scientists face difficulties in identifying the components of the dye used, especially when the substance is organic. It is easier for some of its properties to change over time and under the influence of light. Therefore, detecting the composition of the dye used in coloring is considered an ongoing process due to advances in knowledge of material properties and continuous discoveries. Furthermore, the difficulty in determining the quality of the dye lies in the fact that the remaining color is often residue rather than the original composition. Additionally, understanding the composition of color is complex, as most colors are composed of multiple substances or multiple colors to achieve the desired shade<sup>70</sup>.

Expanding beyond the mentioned three cities that have been highlighted, we cannot forget the vibrant colors of the painted tombs in El-Mozawaka, nor the brilliance of colors in the temples of Hibis, Al-Zayan, and many other decorated buildings in the oasis cities.

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<sup>70</sup> Maurizio Aceto, 2021, 15 – 16

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