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The WWII Bunkers of the *Hôpital Morvan*—Brest (FR)

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Abstract

A search at the *Archives Départementales du Finistère* in Quimper permitted to find documents indicating the presence of WWII bunkers in the area of the nowadays *Hôpital Morvan* in Brest. However, the visit of the area permitted to ascertain that several more bunkers were actually built. The visits permitted their identification and to ascertain that some of them are presently in good preservation state, others partially demolished and integrated in a modern hospital building, and some other completely demolished. The bunker demolition technology employed is documented by images and commented. Notwithstanding the ancient hospital buildings were classified as historical monuments and so protected against alterations and demolitions. No protection is ensured to the bunkers which risk is to be altered or demolished according to circumstances, depending on the development of the hospital.

Keywords

WWII, Brest, Atlantic Wall, *Hôpital Morvan*, Bunkers, *Blockhaus*, *Organisation Todt*

1. Introduction

It was the fortuitous encounter, in the past, with a WWII Great Bunker in the area of the nowadays *Hôpital Morvan* in Brest that pushed us to visit the area in looking for possible other WWII constructions. An article published on the newspaper *Le Télégramme* (Le Guen, 2023) informed that three WWII bunkers actually existed in the area and that the Great Bunker escaped the destruction because of the high demolition costs and two others were partially demolished and integrated in a new building. This information pushed us to a detailed investigation and to further visits on the area.

2. Hospital History

At the beginning of 19th century, the hospital district of Brest comprised eighty-four municipalities for a total of 250,000 inhabitants and had only an old, 590-beds hospital at the town centre dating from the XVIIth century. Its antiquated state and exiguous numbers of beds let apparent to the Municipality the urgency for a new, spacious and modern furnished hospital (Lullien, 1946a).

The question of the construction of a new hospital in Brest ascended to 1863 and was raised in different occasions, but it entered in the decisive phase on 1929. The chosen terrain was situated outside the Brest walls on an area named *Camps des Fédérés* dominating the Bay of Brest. It was oriented North-South and extended on nine hectares. The Administrative Commission on 21st January 1930 decided to proceed to the area expropriation in the shortest possible delay and to establish a hospital draft construction project.

The French Presidential decree of 23rd June 1931 declared the public utility of a new hospital in Brest. The Brest mayor was authorised to acquire by expropriation the area necessary for the project. The cost of 3,201,275 Frs was paid by resources coming from the alienation of part of the endowments and by a loan of 1500000.00 Frs contracted with the *Caisse des Dêpots et Consignations*.

The competition for the choice of an architectural project took place on 13th June 1932. The appointed Jury selected the *Nord-Sud* project of Lopez and Gravereaux architects of Paris. The project which, initially, envisaged 500 beds was ampliated to 800 and successively to 1000 beds. The Administrative Commission deliberated to invite the architects to submit a draft project for the appreciation of the Superior Council of Hygiene.

In the meeting of 2nd November 1933, the Administrative Commission set to 45000000.00 Frs the sum to not exceed for the construction of the new hospital, comprising the cost of the materials. On 4th December 1934, the Administrative Commission deliberated an estimated expenditure, in round figures, of 45976000.00 Frs for the terrain, the construction and the adaptation of the buildings. To deal with such a sum it was decided to obtain a state subvention of 50% through the fonds of *Paris Mutuel* and to cover the rest by a General Council subvention decided on 10th October 1934, a loan to be contracted with the *Hospices de Brest*, the sale of the old hospital, the products of the Metivier legacy and annual securities (Ropass, 1942).

The project finally envisaged the institution of 800 hospitalisation beds, 106 personnel beds, 10 departmental childbirth school beds, a central steam and hot water production plant, a general kitchen, staff canteens, a pharmacy, material depots, stores, workshops, a laundry, a general hydrotherapy service, a central bakery, a dead service, a consultation building with anti-tuberculosis and anti-venereal dispensaries, lodgements for the Director, the Treasurer, midwife masters, internal guards and the accommodation of a religious community for 25 nuns with a chapel. On 24th June 1936, the hospital general plan was approved by the French Public Health Ministry (Tandas, 1941).

Because of difficulties in acquiring the financial resources, the Administrative

Commission had to wait the Programs of Great Works for acquiring the sum for starting the construction of the new hospital. With respect to the full new hospital project, the Administrative Commission decided to proceed with a first hospital tranche, corresponding to a half of the project, comprising the construction of a Consultation Pavilion, a Maternity and Surgery Pavilion, and a Small Payers Pavilion of 470 beds, waiting for the second construction tranche comprising a boiler house, workshops and enclosure walls (Ropass, 1942).

The earth moving works started on 1936. The laying of the first stone took place on 3rd November 1937 (Lullien, 1946a).

The work progress was somewhat thwarted by the application of the 40-hour week and severely hampered by the provisions of the decree of 12th November 1938 dealing with the revision of public works. A demand of derogation addressed by the Administrative Commission received satisfaction, but strictly for the works necessary to the preservation and protection of the buildings already built, exterior glazing, sewer system and lightning rod installation. The raw construction materials, mainly reserved for the armament effort, were rarefied. When the French mobilization occurred, the site was virtually closed. Nevertheless, the rainwater and other drainage works were already commissioned. The structural works of roofing and waterproofing, interior and exterior carpentry, as well as the installation of a wastewater treatment plant, were practically finished when the war against Germany was declared. In normal times, the termination of the first tranche was planned for July 1942 (Ropass, 1942).

On 13th September 1939 the representative of the First Sub-Area Base of the British Army declared to have taken possession of the ground floor and of the 1st to 4th floors of building No. I. A visit of these floors permitted to ascertain that no traces of degradation were brought to the structures (Kermack, 1939). The British Army used these floors as garrison; subsequently, the *Marine Nationale* used these floors as material depots (Lullien, 1946a).

After the German invasion of France, on 4th December 1940, a first requisition of the hospital buildings until an indefinite date took place by order of the German occupation authority. Interrupted for about six months, the construction works resumed at the end of February 1941, thanks to the financial assistance to the Administrative Commission by the Armistice Commission. The work continuation had the purpose to allow the use of the hospital as Marine hospital under the direction of the architects who received instructions for the completion of the works directly by the German *Marine-Bauamt*. To give satisfaction to the German authorities, the Administrative Commission asked the Brest prefect to proceed to the tendering of works according to the conditions of the Circular No. 97 of the French Ministry of Public Works of 6th October 1939 (Ropass, 1942).

A second requisition assigned the buildings as naval quarter for the German *Kriegsmarine* (Lullien, 1946a). The *9. U-Flotille* constituted on 1st September 1941 in Brest, arranged its quarters in the new hospital buildings the construction of which continued as ordered by the *Kriegsmarine*. It decided, at the be-

ginning, to install there its military hospital (Hellwinkel, 2022). During the work running, the project parts suffered deep modifications which escaped to the Administrative Commission. However, the architects tried to save the interest of the Administrative Commission. They were able to follow, in agreement with the German authorities, the corrections made to the plans, avoiding many demolitions and very expensive recoveries (Ropass, 1942). Two documents (Cleuss, 1941a; Cleuss, 1941b) mentioned the occupation of about three hectares of the area of the new hospital on the Avenue Foch by the *Oberbauleitung Nord*, *O.T.*, *Einsatz Westküste*, *Abteilung Nachschub Ju: La*, *Einheit*, *Feldpost 43903*, without defining the purpose. The bombardments of 10th February and 15th April 1941, which destroyed the old hospital except for the Administrative Pavilion, rendered necessary the completion of the new hospital with shorter delay (Tandas, 1941).

On 5th December 1941, the Inspector and Manager of Naval Works in Brest with the letter No. I806/2 made known that all the buildings of the new hospital have to be completed for receiving German soldiers. This letter modified the Convention of 3rd December 1940 according to which no important changes were foreseen to the original program and all the buildings have to retain their hospital character (Ropass, 1942).

The Application 400 to the *Service d'Aide aux Forces Alliée* and to the mayor of Brest (Hurley, 1944) informed that the buildings No. 1 and No. 2 of the new hospital (**Figure 1**) were occupied by the American Army from 21st December 1944.

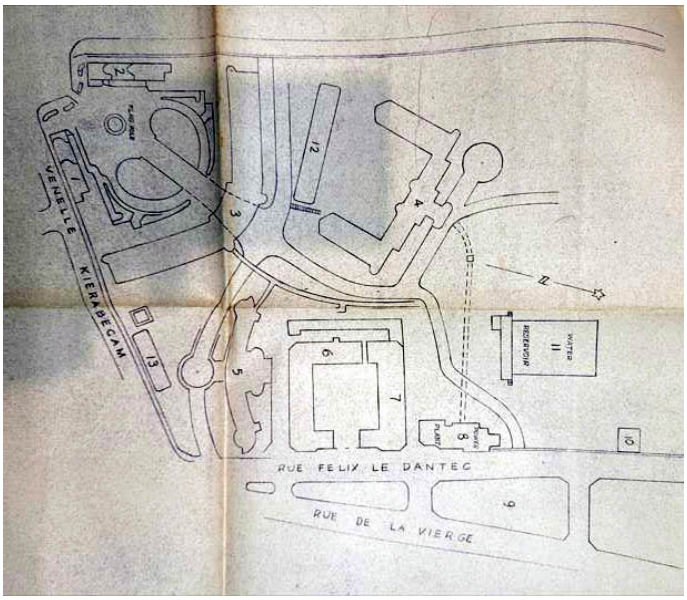


Figure 1. Plot Plan—Civil and Military Hospital—Brest, Office of the Engineer, Brittany, Base Section—Com. Z. Etousa—1 building No. 1; 2 building No. 2; 3 Consultation Pavilion; 4 Maternity and Surgery Pavilion; 5 Small Payers* Pavilion; 6 building No. 6; 7 building No. 7; 8 Power Plant bunkers and annexed house; 9 Felix Le Dantec road buildings; 10 bunker SK; 11 Water reservoir; 12 Great Bunker—*SK/M* × *3*; 13 bunker *SK/M* × *2*. (Hurley, 1944) * Small payers were persons able to pay only part the medical expenses.

On 23rd October 1946, the French Reconstruction and Urbanism Ministry decided the reconstruction of the Civil Hospital of Brest damaged by the bombardments of August and September 1944 and the German occupation during the years 1940-1944 subject to the eventual recovery of the works made by the enemy (Lullien, 1946b). The *Marine Nationale* acquired the hospital buildings for concentrating different serviced dispersed in the town, despite the opposition of the Brest major and the hospital administrators. An agreement was reached between the *Prefect Maritime* and the Brest major according to which the *Marine Nationale* abandoned the Consultation building and the hospital entrance buildings at the demand of the architects of the new hospital and a third building, in principle, on 1st January 1947. This permitted the resumption of the completion works of the first hospital tranche. The completion works of the new hospital continued following the reconstruction of the town of Brest (Lullien, 1946a).

A document (Lullien, 1947) listed the constructions built during the hostilities on the territory of the municipality of Brest. **Table 1** specifically mentions a basin and two bunkers or shelters in the new hospital area without specifying their characteristics; however, the visits on the area permitted to establish that more than two bunkers were actually built (**Figure 1**).

Table 1. Constructions built during the hostilities in the area of the new hospital (Lullien, 1947).

Structure	Description Surface etc.	Emplacement	Preservation State
Basin	Water reservoir against fire	Courtyard of the New Hospital	Good
Concrete shelter	2 reinforced concrete bunkers	Dependence of the New Hospital	Good

On January 1951 the new hospital received its first patients. It was officially inaugurated on 1953 and dedicated to the Breton physician and politician August in Morvan.

A document of the hospital Economic Services (Services Economiques, 1957) informed that a bunker facing the central boiler house, hosted a transformer station and a water reservoir superimposed on the couverture. Because of rain water infiltrations in the transformer station, possibly causing severe accidents, the bunker sealing was carried out and the reinforced concrete water reservoir was demolished. The works involved an ex-penditure of 529859.00 Frs.

3. The Visits

Various visits on the area of the *Hôpital Morvan* (**Figure 1**) took place from 2nd December 2018 to 5th September 2023 and the last on 16th September 2023. The WWII constructions identified were the following.

A pale orange painted Official Housing 8a (48˚23'40.54"N, 4˚29'6.41"W,

Figure 2. Water reservoir and WWII bunkers in the new hospital area after the WWII-4 building No. 4; 5 building No. 5; 6 building No. 6; 7 building No. 7; 8a Official Housing; 8b bunker; 8c bunker; 8d bunker with possible *tobruck* superimposed; 8e power generator bunker with superimposed water reservoir; 8f aerial electrical power line from bunker 8e to shacks near building No. 4; 9 Felix Le Dantec road building; 10 bunker *SK*; 11 water reservoir; 13 bunker *SK/M* × *2*; 14 bunker *SK*.
C0417-0351_1946_CDP2274_0174, no. 174, 1/1425, Argentique, 13/12/1946

(a) (b)

Figure 3. Bunker *SK 10*—(a) external view; (b) plan.

height 71.5 m) (**Figure 2** and **Figure 3**) (Appendix **Figure A2**), which probably hosted the lodgements of the Director and the Treasurer. Its external structure was in good preservation state without damages due to bombardments or combats. The interior was inaccessible; therefore, it was not possible to ascertain the internal preservation state.

A bunker 8b (48˚23'40.54"N, 4˚29'6.48"W, h. 71.42 m) completely demolished. A portion of its portal and its underground rooms were integrated in a new building.

A bunker 8c (48˚23'40.01"N, 4˚29'6.41"W, h. 71.37 m) partially demolished. A side wall portion on Le Dantec road and its underground rooms were integrated in the new building.

A bunker 8d (48˚23'40.01"N, 4˚29'6.32"W, h. 71.27 m) partially demolished. A side wall portion, letting visible formwork traces and *Ero Vili* pebbles (Tomezzoli & Marzin, 2015). Its underground rooms were integrated in the new build-

ing.

A 12 × 12 m bunker 8e (48˚23'39.26"N, 4˚29'6.24"W, h. 70.87 m). Its external structure, letting visible formwork traces and *Ero Vili* pebbles, was in good preservation state without damages due to bombardments or combats. The interior was inaccessible; therefore, it was not possible to ascertain the internal preservation state.

The Felix Le Dantec road building 9 (48˚23'40.45"N, 4˚29'4.76"W, h. 71.72 m), of French construction, was in good preservation state without damages due to bombardments or combats. Two building inhabitants, interrogated by the authors, excluded the presence of a bunker in the internal building court.

A bunker *SK* 10 (48˚23'43.31"N, 4˚29'7.61"W, h 72.65 m) integrated in a new building (**Figure 3**). Its external structure, letting visible formwork traces and *Ero Vili* pebbles, was in good preservation state without damages due to bombardments or combats. The internal rooms were in good preservation state and used as material depots.

A 50 × 20 m water reservoir 11 (48˚23'41.67"N, 4˚29'7.76"W, h. 71.54 m) buried in the terrain under a hospital parking.

A 14 × 45 m *SK/M* × *2* bunker 13 (48˚23'34.34"N, 4˚29'6.65"W, h. 64.11 m) completely demolished after the WWII.

A 7 × 14 m *SK* bunker 14 (48˚23'33.99"N, 4˚29'8.75"W, h. 63.23 m) disappeared.

A 68 × 13 m *SK/M* × *3* Great Bunker 12 (48˚23'36.3"N, 4˚29'13.53"W, h. 62.6 m), also named *Grand Blockhaus* (**Figures 3-6**) (Appendix **Figure A1**). Its external structure was in good preservation state. Only one of its corners appeared slightly damaged probably because of the removal works of the terrain on its sides and coverage (**Figure 2**). On the front side, six entrances were in good preservation state preserving their original white painting. On the walls formwork traces and *Ero Vili* pebbles were clearly visible. Bitumen traces, probably for watertight insulation, were clearly visible on a corner. On the rear side was visible a *tobruck*, or chimney or emergency exit not in the original plan (Appendix **Figure A1**). The interior was in good preservation state preserving some armoured doors, the original white room and corridor painting and dark grey skirtings. All the original furniture disappeared and only aeration conduit portions were in place on the walls. Some internal rooms were occupied by hospital archive material and audiometric materials no longer in use. A portion occupied by the Hospital Workers' Association was not accessible.

4. The Partial Demolition of Bunkers 8b - 8d

Figures 7(a)-(j) document the partial demolition phases of bunkers 8b - 8d.

Figure 7(a) and **Figure 7(b)** show respectively bunker 8b, provided with an entrance portal letting visible formwork traces, bunkers 8c with three entrances, bunkers 8d - 8e on the background before the bunker 8b - 8d partial demolition.

Figure 4. Great Bunker and buildings in the new hospital area after the WWII-1 building No. 1; 2 building No. 2; 3 building No. 3; 4 building No. 4; 12 Great Bunker. C0417-0351_1946_CDP2274_0038, no. 38, 1/1530, Argentique, 30/10/1944

(a)

(b) (c) (d)

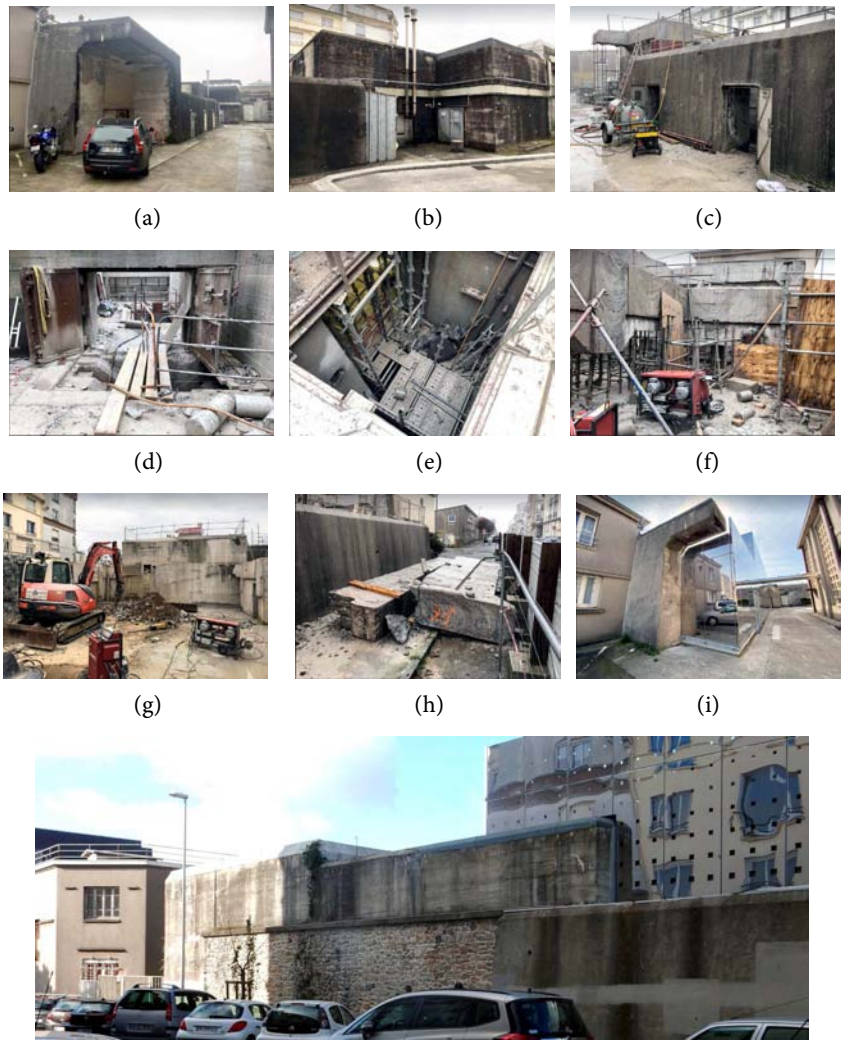
(e) (f) (g)

Figure 5. Great Bunker external details—(a) front side with entrances; (b) corner with air intake grilles and bitumen traces; (c) *Ero Vili* pebbles and formwork traces; (d) ground floor emergency exit; (e) first floor emergency exit used by the conditioning system; (f) rear side *tobruck*, or chimney or emergency exit (g) rear side and coverage, on the far right the *tobruck*, chimney or emergency exit.

(a) (b) (c)

(d) (e) (f)

Figure 6. Great bunker internal details—(a) internal stairs; (b) rest room; (c) hour dial; (d) ventilation system grid; (e) Out of service house Entering prohibited; (f) ventilation system valves.



(a) (b) (c)

(d) (e) (f)

(g) (h) (i)

(j)

Figure 7. Power plant bunkers—(a)-(j) Power Plant bunkers partial demolition phases.

Figures 7(c)-(g) of 2nd December 2018 show respectively: the complete demolition of the bunker 8b of which only a portal portion remained sustained by metallic columnar supports and two opened doors of bunker 8c for its partial demolition start; an internal open, armoured door and the stair to the bunker 8c underground floors during the partial demolition works; the adaptation works of bunker 8c underground; the concrete sawing machine with two electrical motors and two pulleys to direct the concrete sawing diamond cable, at the bunker 8c interior; two detached bunker 8c concrete portions laid on Le Dantec road.

Figure 7(h) of 6th January 2019 shows the debris clearing and adaptation works of the bunker 8c interior: on the left excavator bulldozer, in the middle internal stair and access opening of bunker 8d, on the right the concrete sawing machine with attached sawing diamond cable.

Figure 7(i) of September 2019 shows bunker 8b portal portion remains integrated in the new building.

Figure 7(j) of 5th September 2023 shows the remains of bunkers 8c - 8d and bunker 8e on Le Dantec road.

5. Discussion

The various documents studied at the *Archives Départementales du Finistère* in Quimper on 13th July 2023, 18th July 2023 and 14th August 2023 are silent about the bunkers, built by the *Organisation Todt* (*O.T.*), in the area of the new hospital (**Figure 1**). Although under the direction of the O.T., therefore under military secret, their construction was certainly be remarked because of the presence and the work of excavators, trucks, mixing machines and a great number of workers which surely perturbd the hospital area.

It was a common practice of the *Wehrmacht* to provide, where possible, the hospitals it occupied with at least a first-aid bunker in order to continue medical activities also during attack, as in the case of the bunker *R118* near the *Hôpital des Rosais* in Saint-Malo (*AOK7*, *KVA A1*, *KvGr Rance*, *KvUGr Festung Saint-Malo*, *Les Rosais*, *Ra281a*) (Tomezzoli & Pottier, 2016a). Therefore, the presence of bunkers in the area of the new hospital is not surprising. However, here the bunkers added a further purpose. The *9. U-Flotille* occupied the new hospital buildings (**Figure 1**) as follows: 1 Guard and Officers of personnel reserve; 2 *Flotille* commander lodgement, 3 *Flotille* administration services (*Haus Endrass*); 4 *Flotille* seamen lodgements (*Haus Gilardone*); 5 *Flotille* officers lodgements (*Haus Jürst*) (Biron et al., 2023). The Great Bunker 12 placed between the buildings 3 and 4 was foreseen for accommodating and protecting administrators and seamen in case of air attack and bunker 13 in front of building 5 for accommodating and protecting officers. The air attack protecting function of Great Bunker 12 and bunker 13 was actually the same accomplished by the German bunkers 47, 50, 56 of the *BDU* (*Befehlshaber der Unterseebootes*) West, admiral Dönitz, on the *Domaine de Pignerolle* (Tomezzoli, 2019).

The water reservoir 11 was intended as a pool as those at *Murs Erigné* (To-

mezzoli, 2016) and at the *Domaine de Pignerolle* for providing relax to the officers and seamen and water in case of fire to the buildings and bunkers in the hospital area (Tomezzoli, 2019). An athletic field was arranged between the water reservoir and building 4.

It is also not surprising that the vital devices of the Power Plant were protected by bunkers.

The technology adopted for the partial demolition of the bunkers 8b - 8c differs from that used for demolishing, on 2011, the *R661 Kriegsmarine* first-aid bunker of 1942 on the *Collège Moka - Sainte Famille* estate at Saint-Malo. That bunker faced the lines of the old Saint-Malo railway station and because of its position in the city area, the use of sticks of dynamite was inconceivable. The firm Karavis from Rennes drilled in *R661* concrete structure 650 holes of different depth in which expansive gas cartridges were slipped. Then, the bunker was enveloped with hay bales and covered by plastic sheeting, a new way for limiting the dispersion of concrete debris and mitigating noise and vibrations in the ground. The cartridges explosion weakened the *R661* structure opening cracking everywhere. Concrete portions and debris were evacuated by the city public services (Tomezzoli & Pottier, 2016b).

The bunker 8b (Appendix **Figure A2**) plan and images let no doubt about that it was used as garage or material store, the bunker 8e was used as a transformer station (Services Economiques, 1957), the usage of the other bunkers is unknown.

The Great Bunker plan is shown in Appendix **Figure A1**. It comprised a ground-floor (*Niveau Bas*) hosting the six front side entrances and a first-floor (*Niveau Haut*) hosting an emergency exit on each of its minor sides. The emergency exit of the ground floor is not present on the plan. Each floor was subdivided in three equal sections, each arranged around a double internal stair. Each section comprised four rectangular rooms, two facing the longer sides of the double stairs and two facing the minor sides. The tobruck or chimney or emergency exit (**Figure 6(d)**) is not present on the plan. The images of 1946 (**Figure 2** and **Figure 3**) show that, in origin, its coverage and three of its sides were covered by terrain letting uncovered only the front side with the six entrances. After the WWII a portion of it accommodated an audiometric division because of the bunker acoustic isolation and then an ophthalmological division. Nowadays, only a portion is in use by the hospital dependant Association. No further use of it is foreseen, although its coverage would be suitable for the landing of helicopters and drones.

A tunnel, about 130 m long, connected the Power Plant bunkers with the hospital building 4 (**Figure 1**) allowing the distribution of electricity and warm water. The construction of modern hospital buildings caused the suppression of the bunker 8e aerial electrical line and the shacks near building 4 (**Figure 2**).

Figure 2, **Figure 4** and **Figure 5** show that the area of the new hospital was not seriously damaged by allied air bombardments and battle of Brest combats.

6. Conclusion

Our visits and documentation study permitted to ascertain that eight bunkers were actually built in the area of the actual *Hôpital Morvan*. The Great Bunker and the other remaining bunkers are not classified as historical monuments notwithstanding all the ancient hospital buildings are so classified and so protected against alterations and demolitions (Le Guen, 2023); therefore, no protection is ensured to them against the risk to be demolished, according to the circumstances, due to the development of the hospital. Moreover, no information is given to the public about their existence and purposes. We hope that this article will attract the attention of archaeologists, administrators, scholars and a large public about the necessity of the preservation of the German military constructions in the *Hôpital Morvan* area.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this article.

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Appendix

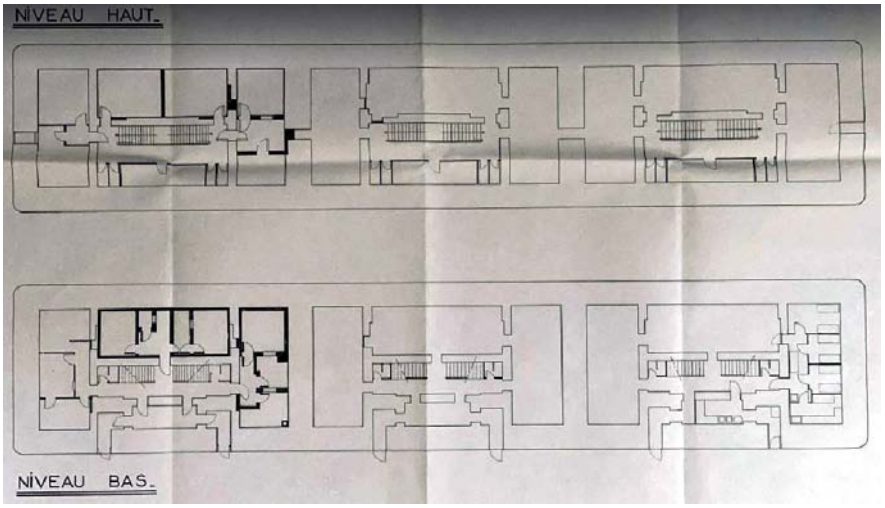
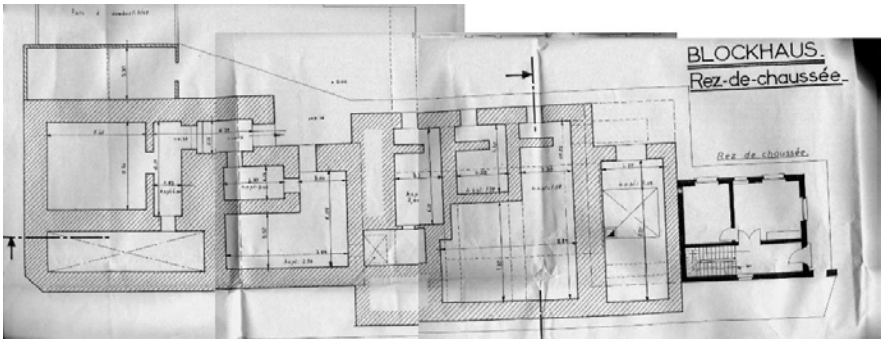
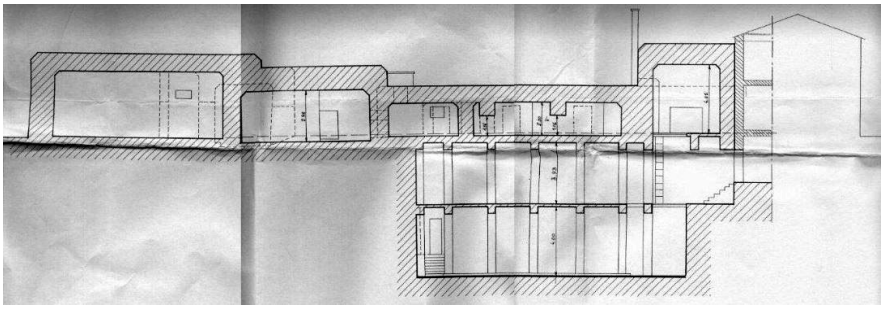


Figure A1. *Hôpital Morvan* Great Bunker (12) plan—Level High, Level Low.



(a)



(b)

Figure A2. *Hôpital Morvan* bunkers 8b - 8e—(a) Bunker ground floors (*BLOKHAUS - Rez de chaussée*); (b) Underground levels.

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Bâ as an Example of the Ancient Egypt Religious Thought in Effect on Ancient World Civilization until the Renaissance Era

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Abstract

This research article investigates the development of Bâ as an example of the ancient Egyptian compound figures throughout the ancient world civilizations up until its decline in the renaissance era. The article consists of three sections. First, it investigates the origin of the Bâ in the ancient Egyptian civilization. The second section investigates the development of the Bâ figure to the Seren in the Greco-Roman and Byzantine civilizations. The final section addresses how Seren was developed into the concept of a Harpy compound figure in Islamic civilization, from the Fatimid era, up until its decline in the era of the renaissance. This paper follows a descriptive research method, conducting a comprehensive review on the human-headed bird imagery, how it is depicted in different eras, and what their symbolic representations were. The article provides a comprehensive overview of the development of the Bâ/Seren/Harpy as an example of compound figures, which corresponds to how compound figures were perceived and theorized. Implications include understanding the purpose of compound figures and the rise and fall of such concepts in the ancient world.

Keywords

Bâ, Seren, Harpy, Human-Headed Bird, Pottery, Lusterware

1. Introduction: The Origin of the Bâ

The ancient Egyptians had a set of components and elements that played an im-

portant role in the person of the deceased and these components could be classified into material and social components, and the material can be confined to "body, limbs, corpse, ba, shadow", while the social was "ka, name, mummy" (Assmann, 2011: p. 89). The research problem with the human-headed bird imagery is that it has acquired different names throughout different eras (Ba, Seren, Harpy), but the meaning and representations were different in each era; and hence, the research objective is to investigate the human-headed bird imagery throughout different eras and investigate how it was depicted and the symbolic representation it held in each era.

1.1. The Definition of the Bâ

At the forefront of these components and elements is "Ba", which we call "spirit", and in the fact that the word "spirit" is not the most accurate meaning of this complex element that is difficult to describe and define in one word to the extent that the Christians of Egypt, when they translated the "New Testament" into the Coptic language, completely abandoned the translation of this word, because they realized that it does not express the deep concept that corresponds to Christian concepts and replaced it with the word **Psyché**[1], and what makes it more difficult is what is known in the name of "Alka", which was considered by some as "consort", which is also an inaccurate meaning[2].

But we are forced to deal with them as the consort and the soul, and we can say that "Ba", which belongs to the physical or spiritual milieu, enabled the deceased to move and pass through the world of the dead, then to the courtroom passing through the fields of Oser and then joining the compound of the sun god "Ra", and beholding the deceased was able to return to the world of the living, it is a "free spirit" that can join and separate from the corpse at any time, and this was expressed in the coffins of the human body in the late era, which included a text on the chest of the coffin (where the site of landing Bâ to unite with the corpse).

1.2. Analysis of Texts Mentioning the "Bâ"

Many texts confirmed that "Bâ" belongs or ascends to heaven, while the body or corpse belongs or descends to the earth, and this can be read in the text directed from "Nabat Hat" (Nephthys) to "Tutankhamun", saying: "Your Bs belong to heaven in front of Ra; your body is (Assmann, 2011: p. 88) **in the earth with Osir, daily you rest (rest) on your body**" (Piankoff & Rambova, 1955: p. 65), and here it is necessary to differentiate between the "Bâ" of the average person, and the "Bâ" of the king; the first may be judged negatively by the court of the dead, and therefore do not enjoy his immortality, but the kings must join the sky where the sun god "Ra" and the "Bâ" of the king enables him to hwork as a god

[1]Daniel, F., The civilization of Egypt pharaonic, Paris 1987, p. 226.

[2]The first to know "Alka" as the "consort" was "Maspero" because of the scenes that depict another figure accompanying the king in the same form, In general, both gods and humans had "Of" But the gods and kings had several. "Kaat" Sometimes there are fourteen, for more see: Ibid, p. 225.

among the gods where he became [3]**Ax** Because of his epidemic and this is confirmed by the texts of Al-Ahram.[4]

Ancient Egypt was associated with its neighbors with cultural links that grew and developed over the years, and with the expansion of the size of the Egyptian Empire in the modern state, relations increased significantly, and during the era of the third transition, Egypt was ruled in the twenty-second dynasty by kings of Libyan origins, and in the twenty-fifth dynasty Egypt fell under Kushite rule, then with the beginning of the twenty-sixth dynasty, the foreign presence in Egypt increased greatly so that they resided in their own colonies, followed by the Persian occupation of Egypt, which was reflected In the introduction to Chapter (125) of the "Annie" Papyrus of the trial, some of it concludes that the arrival of Egyptians to the courtroom also includes the arrival of different nationalities, and that the dialogue that takes place with the gatekeeper is attended by "Thoth" as an interpreter between foreigners and the guard, and therefore the foreigners were sharing the Egyptians' concepts of the other world, and this view is supported by the recitation (1130) of the texts of the coffins (Quirke, 2013), as shown in **Figure 1(a)**: which says:

At the fifth hour of the Book of Gates, specifically in the scenes of the lower row, there is a very important text that talks about three races (Asiatics, Nubians, Libyans), the text says:

It seems from the text that the ancient Egyptians believed that the whole human race was created by "Ra", he created them from his tears, including foreigners, and therefore they are held accountable in the court of the dead and their souls fly in the other world like the Egyptians, and if this is the thought of the Egyptians towards foreigners, did foreigners have the same thought? (Zandee, 1977: p. 239)

1.3. Geographic Locations of the Bâ

In fact, through archaeological evidence, it was found that the idea of "Bâ" has moved to the ancient country of Sudan, specifically the Meroitic civilization as shown in **Figure 1**, which developed the form of "Bâ", where this civilization produced statues of "Ba"[5] for the deceased in a complete human form, which was not known in ancient Egypt, so we find "Ba" in the form of a female depicted in the form of a woman Winged with drooping breasts This form is dated to the first half of the first century AD or earlier as shown in **Figure 1(b)**,

[3]Here a distinction must be made between "spirits Bâ", "Powers Bâ". The latter is the one who is depicted in the form of birds jabiru They are the ones who can be punished, but "the spirits of Bâ" Imagine next to the sun god either carrying the rope of his ship or worshipping him, and these spirits are accompanied by shadows, for more see: Nivinsky, A., the Double Structure of the Entity: the Ancient Egyptian conception of the human being reconsidered, In Proceedings of the Fifth Central European Conference of Egyptologists, Pułtusk 2009, p. 159.

[4]CT I, 789a;  **This power has become an Akh because of his Bâ** Zabkar, L., A study of the Bâ Concept, p. 71.

[5]Turkish, L., Between Two Worlds: the frontier region between ancient Nubia and Egypt, 3700 BC-AD 500, Leiden 2009, pp. 422-424.

I created the gods from my sweat, and human (people) from the tears of my eye[6]
(Faulkner, 1978: p. 167).

sḫpr.n.i nṯr(w) m fdt.i iw rmṯ m rmwt irt.i

(a)

nṯṯn rmwṯ ȝḫt.i m rn.ṯn n rmṯw ʿȝ mw n sḫpr in.tn m rn.ṯn n ʿȝmw ḫpr n.sn sḫmt nts nḏt bȝw.sn nṯṯn nn ḥwi.i r. sn ḥtp.i m ḥḥ pry im.i m rn.ṯn n nḥsyw ḫpr n.sn n Ḥr ntf nḏ bȝw.sn

ḥḥy.n.irt.i ḫpr.n.ṯn m rn.ṯn n ṯmḥw ḫpr n.sn sḫmt nt(s) nḏt bȝw.sn

you are tears of my eye, in your name of mankind (human beings)[7], great water of creation, you say in your name of Asiatics, "Sakhmet" came into being, she protects their *bȝw*-souls, you are these against whom I hit, I am satisfy with the million (who) came forth from me, in your name of "Nubians", Horus come into being, he is protects their *bȝw*-souls, I searched for my eye, (when) you came into beings, in your name of "Libyans", Sakhmet come into being, she protects their *bȝw*-souls.

(b)

Figure 1. (a) The quote in hierographic language and transliteration showing the introduction to Chapter (125) of the "Annie" Papyrus of the trial. (b) Ba-shaped limestone woman from the Meroitic civilization, second century AD, British Museum.

[6]CT VII, 1130.

which means that the form of "Bâ" continued in the country of Sudan until the first millennium AD, and it is of course an evolution from the Egyptian "Bâ" form, which was usually depicted in the form of [7]a full "jabiru", and this sign means soul or Bâ With the beginning of the modern state, it was sometimes depicted with human arms and hands, and the falcon became one of the birds that symbolize the "Ba" idol "Soccer" according to the book "Alami Duat", and when this body ends with a devotee of a god, it refers to the spirit of God (Gardiner, 2007: p. 471).

And during the late era in Egypt Appeared "Bâ" On some funerary paintings. For foreigners Egyptians Like a tombstone found in Saqqara for the Phoenician Syrian "Khe - Love", that Pictures sitting in the upper row with hair, beard and clothes Greek Despite its Semitic origin[8] and in front of him is a bird. "Bâ" in an Egyptian body Traditional as shown in **Figure 2**. [9]This clearly indicates the leakage of Egyptian religious ideas among foreigners. at that time, and perhaps with time these ideas moved to neighboring countries‹ We may notice that Considering To the religious beliefs of the inhabitants of Mesopotamia when they believed that Human A composite object of two elements, the physical element that It is expressed by the body, and the second is a spiritual or invisible element and is expressed by the soul, and this belief is consistent with ancient Egyptian beliefs, even if the concept of the soul is multiple among the Egyptians, and the Sumerians have launched the word GIDIM On the deceased and his soul, but Akkadians They expressed the soul with a word etemmu that is separated from the body at death (Hanoun, 1986).

Figure 2. Upper part of the painting "Kha-hab", Berlin Museum.

[7]Turkish, L., Between Two Worlds, p. 423. It continued to say the least until The end of the third century and the beginning of the Fourth Gregorian, perhaps the indication and understandable Their "Bâ" has begun Faded Over time.

[8]He's a foreigner. Who is it Semitic origin lived according to the text Demotic Accompanying the painting in the period between 273 and 203 BC, he bore the title of "chief of the army of the Medes", and the name of an important place is mentioned on this painting: "With - Up - Yahet" means "the land of Yahu" or "the land of the Jews" and perhaps it refers to the ghetto in the city of "Memphis", and therefore this painting and its owner Confluence For several different civilizations and nationalities, see: Vittmann, G., Egypt And the Strangers in First BC Millennium, Mainz: Philipp von Zabern 2003, p. 70, Abb. 33.

[9]Review a museum Berlin Turns out the painting was destroyed during World War Second However, the museum still retains the figure used here.

The epic of "Gilgamesh" expressed this in the framework of a wonderful dialogue text in which he tells "Enkidu". His brother Gilgamesh had his vision of dying during his illness, saying:

Oh Khali, last night I saw a vision, it was poison. He thundered, and the earth responded to her, and he stayed. I was standing alone, and a scary, faceless creature appeared in front of me, his face was like that of a thunderbolt bird. "Zou", and his claws Like Allen's nails Secret, he has stripped me of my clothes and my dwelling bomb Claw And he took my throat until my breath subsided, …He has switched He looked at me and led me to the abode of darkness, to the dwelling place (Arkala), to the abode from which no one who entered it returns, to the irreversible path of the traveler, to the abode whose inhabitants were deprived of light, where the dust is their food and the mud is their strength, and they are clothed like a bird with a cloth of wings. Feathers, living in darkness do not Ron Nora, … (Baqer, 2016: p. 70). In general, it makes sense to portray gods and spirits as pure birds or as human beings with wings, as only these two forms enable any creature in the other world. From flying and moving freely (Hanoun, 1986).

From this point of view, we will find that a number of the gods of the East Ancient Dana has been depicted with wings such as the goddess Ishtar and the Persian god. "Ahuramazzda", so that the spirits Evil which is used in magic had wings (Pinch, 1994)[10], and it is the Jedir with to note that such spirits touch "Goblins" have found one of them in "Tanis". It is a bronze statue of an Assyrian goblin called "Pazuzu". It has a votive inscription in Semitic as shown in **Figure 3** (Vittmann, 2003), and knew "Pazuzu" in Mesopotamia as one of the demons of the wind.

Figure 3. Bronze statue of Pazuzu.

[10]The ancient Iraqis believed that there were good and evil spirits which were the most numerous, mostly the souls of the dead who died a violent death, lived on earth unhappy, or the dead who were not properly buried. They were known as "goblins". It is somewhat similar to the concepts of the Egyptians who sought help with evil spirits to inflict damage some neighborhoods, and for this reason the Egyptians resorted to amulets, for more about magic and evil spirits in Egypt and Mesopotamia.

Bâ seems to have met Sought with Foreigners residing in Egypt during the Late Era, so much so that one of them depicted "Bâ" in a new and rare form on an Egyptian Aramaic painting of a person named "Habi Men" Ibn "Akhamnish" It is a name that indicates the intersection of cultures. The first name is Egyptian and means "Apis Baq" (Pinch, 1994), while the second sounds Persian and means "has the usefulness of a friend has filmed the painting is a mummy lying on a bed with stamp Egyptian، In front of him and behind him are the wailers, and the mummy is surmounted by a winged sun disk from which hangs an upright cobra serpent, and here it replaces "Bâ" when it lands to unite with the corpse, It is worth mentioning that "Bâ" in Egyptian beliefs sometimes appeared in a living form with the head of a falcon and means "the sacred Bâ of the pioneer of the Westerners." (Zabkar, 1968: p. 84) And because the disk of the sun represented to the Persians an important signifier represented in their main idol "Ahuramazzda" Perhaps the artist here tried to combine "Bâ" into a living form, and "Ahurmazada" in the form of a sun disk to produce this unique shape as shown in **Figure 4**.

One of the unique scenes that date back to the late era also and greatly emphasize the mixing of ancient civilizations with the Egyptian civilization, and the influence of those civilizations by the idea of "Bâ" is what appeared on the tombstone of Memphis of one of the Persian nobles depicting him as a deceased lying on a bed subject to Near Eastern styles, and standing behind his head two wailing, while at his feet two men also wailing, and on both sides of the painting depicted two mythical beings, the upper half of which is a woman, while the lower half of a bird, and they look very similar to "Bâ" and seem to mourn the deceased as well. As their arms are above their heads as shown in **Figure 5** (Gallo & Masson, 1993: p. 269). It is worth noting that this body of composite beings has been known to the Greeks as "Syrines", and it seems that this tombstone is the best evidence of the emergence of "Syrines" in Egypt, and this may have happened through the Persians, as it seems that the Persians and other foreigners who resided in Egypt have been greatly influenced by Egyptian religious and funerary customs and traditions, including, of course, "Bâ" (Bissing, 1930).

Figure 4. Egyptian Aramaic painting preserved in the Gustav Museum - Lübcke" in Hamm, Germany.

Figure 5. Tombstone of a late Persian notable, preserved in the Berlin Museum.

2. The Development of Bâ to Seren in the Greco-Roman and Byzantine Civilizations

2.1. Circus in Greek Civilization

2.1.1. Seren's Cultural Background

Seren is a hybrid being whose body is the body of a bird and a human face for a female or a human torso for a female mostly has the ability to sing and play, and its origin goes back to the civilizations of the East precisely because this hybrid form did not appear in the Minoan civilization or the Mokyan civilization, and it was often depicted with arms to hold musical instruments and carry the dead (Luker, 2004), the seren was mentioned in Homer's Odyssey where the witch told Cyrce Adissius would sail near the island of Serenat and in order to survive he and his crew must block the ears of his sailors with wax and tie himself to the ship's mast so that he could hear their singing without responding to them and die (Godby, 2011). But rather deceive their heart with their singing and push it to meet its edges, and their danger lies in the beauty of their singing, their extensive knowledge and their promises to their victims to give them this knowledge[11].

2.1.2. Seren in Greek Art

Their first appearance was in the 7th - 8th century BC and was depicted with other fairy animals Sphinx and Algarvin on pottery vessels and with the sixth century BC their depiction became something familiar, as in a three-legged pottery box dating back to 575 - 600 preserved in the British Museum No. (1851, 5507, 7) depicted with opposite serens, including a lotus flower and around it flowers, and the cover of the box with opposite predators as shown in **Figure 6** (Padgett, 2003)[12], and at first the serenity was depicted feminine or masculine.

[11]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, Master Thesis, Victoria university of Wellington, 2014, pp. 24-25.

[12]Islands, The encyclopedia of spirits—the ultimate Guide to the magic of fairies, Genies Demons, Ghosts, Gods and Goddess Harper Collins e-book, 2009, p. 1507.

Figure 6. Three-legged pottery, depicted on the belly of opposite serens, including a lotus flower, and on the lid predators, preserved in the British Museum under the number (1851, 5507, 7) and dating back to 575-600 BC old field, 2014, Figure 17.

The seren was executed in the form of pottery and bronze vessels to preserve perfumes, as in **Figure 7**, which posits a bronze statue dating back to half.

I of the 5th century BC. m found in southern Italy and kept in a museum (92. Ac.5 paul Getty) in the form of a flying body, the head of a woman with hair flowing and above the head a crown is the opening of the aromatic bottle[13] (Oldfield, 2014: p. 90).

The beginning of the appearance of the Seren in the epic of Odysseus of the 6th century BC. As in the Attic pottery with red shapes dating back (475-460) BC. m and engraved in stamnas and preserved in the British Museum under the number 1843.11.3.310 depicted on the body of the pot a ship with five sailors rowing and another tied to the mast of the ship and looking up which is certainly Odysseus and was depicted three sernates body bird and the head of a woman and put a strip on the hair and stand one on each side and the third fall towards the ship and at the bottom a strip of decoration of the maze and from the sides a strip of circular geometric decoration as shown in **Figure 8** (Padgett, 2003: p. 27), some have suggested that she attacks sailors,[14] but it is noticeable that she closes her eyes during her fall and may therefore sail as a result of her failure to seduce Odysseus[15]. As for its presence in funerary art, it appeared extensively on tombstones and on funerary vessels or associated with funerary rituals (Kecn, 1992).

[13]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, op. cit., p. 131.
[14]The-Helw. R, The human Headed Bird Figure in painting from the Bronze Age to the Early twelfth century, on. cit., p. 88.
[15]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, on. cit., p. 27.

Figure 7. Seren-shaped aromatic vessel made of bronze found in southern Italy 5th century BC preserved in a museum Paul Getty under No. 92. AC.5: Old Field, 2014, Figure 22.

Figure 8. Red painted vessels depicted by Odysseus and his crew facing three Attica syllables preserved in the British Museum under number 11 - 3.31 (E-440) - 1943 Quoted in Padgett, 2003: p. 77, Figure 4.

It appeared in a tomb in Asia Minor in (LXCIA) in the southwest of Antolia, one of the tombs of the local ruling family, and Herodotus mentioned that the owner of the tomb is kypernis, the leader of the expedition of the Persian emperor (481-479 xerxes) BC. AD and the tomb dates (470-480) BC. Many elements, including serens, have been depicted mostly outside the funerary context, perhaps to fill the void and give a more intimidating appearance to the tomb, which is inspired by Greek funerary sculptures[16], and it has been depicted with a bird's body and the head of a woman with arms holding human forms resembling children with her arms and feet, as if carrying them in care, and human forms cling to the serenne with their arms like small children as shown in **Figure 9**. It is made of limestone on the south side of the sarcophagus and dates back

[16]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, on. cit., p. 38.

Figure 9. CERN depicted with bas-relief on a frieze from the tomb of the harpy found in the Acropolis Xanthus in Turkey is preserved in the British Museum Citing Elhelw, 2020, p. 190, Figure 4.

to (460-470) BC. Archived in the British Museum (20.10.848) Some[17] have suggested that it is a representation of the kidnapping of the daughters of the Thracian king Pandareus for what he committed[18], but it is probably a decorative work to give awe to the tomb. The appearance of serenas on the tombstones either alone or in the company of sponx was coupled with the need of the deceased's family for a more influential and striking form on the tombstones. It was portrayed in a state of grief and more feminine as if it were a substitute for the grieving family of the deceased or May the kindness and love of passers-by turn to stop to remember the deceased.

It should be noted that the goddess Ishtar, the goddess of love, beauty and fertility in Mesopotamia, was depicted as a with wings and feet of a bird, as in **Figure 10** in a sculpture 49.5 cm high, 37 cm wide and 4.5 cm thick found in southern Iraq and preserved in the British Museum in London. She appears standing on the back of two crouching lions looking at the confrontation and on the right and left his bubble looking at the confrontation and the goddess Trendy hat and holding the ring and stick symbol of authority goddess and stands In a devotional position, bird-like feet standing on the back of two crouching lions[19] appear in a seren-like manner in Greece on tombstones. The seren was depicted in the funerary sculptures free in the form of a flying body and the trunk of a beautiful Badi features of sadness and holding in her left hand the shell of his turtle (Lyra) as if she is playing to relieve the deceased or his loved ones the pain of separation, as in **Figure 11**, which depicts marble statue dating back to

[17]The-Helw. R, The human Headed Bird Figure in painting from the Bronze Age to the Early twelfth century, on. cit., p. 190.

[18]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, on. cit., p. 42.

[19]The-Helw. R, The human Headed Bird Figure in painting from the Bronze Age to the Early twelfth century, on. cit., p. 190; http://www.Britishmuseum.com.

Figure 10. A stone plaque depicted with the goddess Ishtar on the backs of two lions found in southern Iraq with dimensions of 49.5 cm height, 37 cm width, and 4.8 cm thickness preserved in the British Museum Elhelw, 2020: p. 191, Figure 5.

Figure 11. A free sculpture of CERN carrying a lyra (harp) of marble found near the Delphi Gate and dating back to 370 BC, and preserved in the National Museum of Antiquities of Athens under number 774 Old field, 2014, Figure 52.

370 BC. It is preserved in the National Museum of Athens under the number 774[20] and we note the Greek hair in the form of braids and legs of the animal part of the seren, blinded feet like ducks and geese.

2.2. Seren in Roman Art

The Seren appeared as an extension of its presence in Greek art and had such a religious status that the Emperor Tiberies (14 - 37) revered it as it was believed to be highly knowledgeable about what was happening throughout the earth, everywhere and at all times[21].

[20]Oldfield, The sound of serens: Seren Stelae in Classical Attic Cemeteries, on. cit., p. 54.

[21]Islands, The encyclopedia of spirits, the ultimate Guide to the magic of fairies, Genies Demons, op. cit., p. 1505.

It is depicted on a ship with three sailors, although there are seven oars indicating the loss of four sailors, three serens, three dolphins, wingless serens, which is rare to appear without wings, and the bird's part of the serene in the form of a long-legged waterfowl such as swans and bushrush, and the three horns were depicted buzzing on the ship, one of them carrying a harp (**Figure 12(b)**), and the second serene carrying a flute (**Figure 12(c)**), and Adisius tied in the mast of the ship as stated in the advice of the witch Kirki, but here the details of the Odyssey are not adhered to, where it appears that four sailors who have died after being charmed by the Serenat sing it, and the sailors appear frustrated and desperate, where the third appears on the left opens his mouth in frustration and the other bends in exhaustion, it takes them more effort and endurance, and the Serenat laugh as if they are expecting a near victory, their singing will force the sailors to surrender to meet death (Mourão, 2015).

(a)

(b)

(c)

Figure 12. (a): a mosaic in a fountain; (b): Seren carrying a harp; (c): Serene carrying a flute.

Figure 12(a) shows a part of a mosaic in a fountain dimensions 60 × 98 × 260 cm belonging to Cherchell Algeria and preserved in the Cherchell Museum in Algeria (Mourão, 2015).

Here Odysseus overcomes the serenas not only thanks to following the advice of the witch Kirki but also helping the dolphins, the friend of man, who appear in front of the ship as if guiding her to escape the serens, and in this mural she feels that they are the parabola of life, death, creation and destruction, the creation represented by the sea from which Aphrodite was born. As for the destruction, it is represented in the serens, even the serenas are part animal barbarian killer and part human in which the talent of singing as one of the ways of creativity and the witch Kirki is the benevolent female who helps men to overcome the temptation of women and the mural also represents an example of the ability of men to resist the seduction of women (Mourão, 2015).

2.3. Serenas in Byzantine Art

The writings of the fathers scorned the pagan inheritance of Roman civilization In the book of St. Nicophoric Antirrhetic in the early 9th century AD he pointed out that mythical beings are imaginary and pure illusion In the 10th century AD in the book The Life of Basil I was referred to the centaur with contempt and decided that the composite forms and Greek and Roman myths are in general symbols of evil and that this is what interests him As for the poets, they can mention them in their poems as they wish, and in the life of St. Andrew the fool was standing one day staring at Santo and its superstitious beings and giants, so a passerby slapped him on the nape, and told him that he was a fool, the saint father decided that this passerby is a crooked foolish spirit and that these forms for him are symbols of evil, and despite that superstitious forms have been dealt with in abundance in the art of daily life as models of evil, as in an ivory box It is preserved in the Dumbarton Oaks Museum in Washington with decorations of animals and fairy creatures, including a serene with a human head and a falcon-like flying body that comes out from behind the human head an animal head.

Maybe a sheep or a dog, and we notice here the features of the face full of cheeks, the snub nose, the relatively long tail of the bird, and short legs, perhaps the bird is a falcon or a bird of prey as shown in Figure 13(a) (Maguire, 1999: pp. 192-194).

Figure 13(a) depicts an ivory box has a lid with a carving of warriors, one with a shield and a sword and the other is a marksman, and in the side part of the cover is a tape depicted by a man without a beard and a woman in medals, and in the middle of them is a depiction of an emperor inside a medallion and on the body of the box from the front is a depiction of warriors with a depiction of a horse, and in the back is a depiction of three hunters, one of them with a bear and a tape of flower decoration, and the front and back panels are made of elephant ivory, while the side panels are of bone as shown in Figure 13(a) and depicted by sernat with the head of a man with curly hair and a long neck and

Figure 13. (a) An ivory box depicted with fairy animals, including a serenne with a human head from which comes the head of a dog or sheep dating back to the 12th century and preserved in the Dumbarton Oaks Washington Museum Quoted in Maguire, 1999. (b) Ivory box depicted with a carving on the side of two cerennaces, corresponding dimensions of height 19.3 cm, width 19.5 cm, and length 26 cm, dating back to (11 - 12) m preserved in the Museum of Victoria and Brit under No. AB 8-1927 (Williamson, 2014).

the body of a bird of prey was surrounded by opposite sernat tape of plant and fruits of grapes and behind each sern a leaf height of 19.3 cm and length of 26 cm and width of 19.5 cm and the box is preserved in the Victoria and Albert Museum under the number 1927 - ADB and dated to the 11th century - 12AD (Williamson, 2014: pp. 95-99).

As in **Figure 14** on a ceramic dish from Corinthia and preserved in a museum in the Archaeological Museum of Kunthe under No. 2.31.5 dimensions 7.1 cm height 20.8 cm and diameter 20.8 depicted on it Cyrne mostly male with curly hair and look back with sharp features and the body of an aquatic bird with long legs and catches a waterbird, which in turn catches a fish and the scene in its entirety represents dominance and power Valsern controls the bird and the bird controls the fish[22].

Figure 15 depicts a ceramic incense burner preserved in the Museum of Byzantine Art in Athens under the number 1676 t 125, Bm dating back to the 12th century was found in Corinthian depicted with a serne with a male face with short hair and the face looking back and the body of the bird with relatively short legs standing on a plant branch and surmounted by a curl decoration[23].

[22]Maguine. E.D, Cat 189 "Bowl with shore science" (EdS) Helen, Evans, Wixom the Glory of Byzantium: Art and Culture of Middle Byza utine Era A.D 843-1261, 1997, New York, pp. 267-268.

[23]Jonathan Alex. Y, Two unique seren/Harpy Figured Gramics in the Karatay Province madrasah Tile works museum the journal of Anatolian Archaeological studies theft 4, 2021, p. 131.

Figure 14. Ceramic dish depicted with a seren attacking a seabird MAGUIRE, 1997, 267, Figure 18.

Figure 15. ceramic incense burner depicted with CERN belonging to Corinthia and preserved in the Museum of Byzantine Antiquities in Athens under No. T125/Bm 1676 Quoting: Özdemir, 2021: p. 131.

Perhaps the seren appeared in the areas surrounding the Byzantine Empire, which fell under the influence of Byzantine culture and the religious spiritual thought of Orthodoxy, including Kiev and Trey in a golden earring inlaid with enamel dimensions 6.4 × 5.4 cm belonging to Kiev and preserved in the Metropolitan Museum in New York on one side of the throat Photograph of two circular serents looking in front of the face with a halo of light in the middle of them the ball of life and on the other side a depiction of two birds facing each other with similar plants as shown in Figure 16. From the Seren saints anchor the tree of life here the Seren in a decorative and spiritual context.[24]

[24]Brown, Temple pendants, (Ed.) Evan S, Wixon, The Glory of Byzantium: Art and Culture of Middle Byzantine It was AD 843-1261, 1997, 309-310.

Figure 16. Round golden earrings enamelled in the form of cerens, including the tree of life on the other side, facing birds and floral motifs dating back to the 11th-12th century AD and preserved in the Metropolitan Museum Quoting: Brown, 1997, 309311 fig.

It appears from the above that the sernet is linked to art in the context of daily life, especially in expensive goods for women such as ivory boxes, but it is remarkable that the illustrated serenne has a masculine face.

2.4. Seren at in Coptic Art

The Copts viewed the pagan inheritance as a way to express their religion in a hidden way in the early ages of Christianity before Christianity was recognized as a religion of the Roman Empire, so the sign of the gankh was used as a cross and the fish symbolized Christ and the god Aphrodite symbolized purity because it was born from a shell in the sea, and Daphne symbolized victory over evil, and with the progress of time and in the era of Emperor Theodisius I, persecution of paganism appeared, and one of its most important manifestations was according to Ruvinius in his History of the Church (402-403 AD). What Theophilus did after finding a pagan altar beneath a Christian church was to display his tools (Davis, 2017).

Holy in a procession in the streets of Alexandria as a kind of humiliation for the pagans, which provoked their anger and prompted them to confrontations with Christians, and for their small number compared to the Christians, they took refuge in the temple of the Ciprabium, and as a result Emperor Theodinsos issued an order to pardon the pagans and considered the Christians who were killed in that conflict as martyrs, and later Theophilus instigated the Christians and invited the Egyptian monks to Alexandria, who were his effective tool in the demolition of the Serapeum, and he inaugurated the church of Mahalla and the assembly of this monastic and established a church in the Canopus area (Abu Qir current) near the destination of a pagan pilgrimage and persuaded the monks to establish a monastic gathering there, and this indicates in its entirety his religious and political policy to try to liquidate paganism and end its existence by establishing Christian places of worship on the ruins of pagan temples, but the manifestations of paganism in art, especially in the minor arts, continued to use pagan artistic elements from Greek and Roman legends, especially in textiles and minor arts in general, where the serenas appeared as in Figure 17.

Figure 17. A piece of fabric with a leaf-shaped decoration with a peacock surmounted by a bird's body and a human face with geometric motifs of points and zigzag calligraphy, found in Fayoum and preserved in the Louvre Museum under the number (E26370) and dating back to the century (395-641 AD). Quoting: https://collections.louvre.fr/ark:/53355/cl010045447.

3. The Development of Bâ to Harpy in Islamic Civilizations

3.1. Harpy in the Fatimid Era

Harpy was a creature with a female face, a vulture body, and nails. He depicts violent fighting and death (Nouri & Hashem, 2018). The Harpy motif, which depicts the lady bird in the shape of a male person, may be seen on pairs of lusterware ceramics from the Fatimid Period in Egypt. As a result, the Harpy is a composite figure with human heads and bird-like bodies that has completely changed in meaning after the arrival of Christianity in Egypt, when it went from being a religious to a decorative figure (Nouri & Hashem, 2018).

Additionally, the Harpy theme emerged across the Islamic world, from Samarqand in the east to Cordoba in the west (Elhelw, 2020). During the Fatimid period, it was displayed as lustrous decoration on bowls in Egypt and Syria, primarily illustrating royal themes and the joyous life of the court. A bowl with a human head was discovered in Tell Minis in Egypt, the site of the invention of the mina'i method, as an illustration of this (Elhelw, 2020). Although this method was the most uncommon of the Fatimid dynasty in Egypt and Syria in the eleventh and twelfth centuries, its brilliant impact and exceptional imagery make it one of the greatest in ceramics history (Invaluable, 2010).

In a two-dimensional picture, **Figure 18** is depicted as a bird with a man's head wearing a turban, almond-shaped eyes, broad brows, a pointed nose, thin lips, and a wide jawline. The body of the figure appears to be covered in details like Fatimid textiles that were distinguished by beautiful inscriptions, in contrast to prior portrayals of human-headed birds that were featured in feathery bodies and are wearing necklaces. The entire depiction demonstrates the wealth of the Fatimid era (Elhelw, 2020).

Figure 18. Fatimid Bowl with a Harpy. c. 12001250. The Jameel Gallery, case 2 W. (V and A Collections, 2017).

The following wooden board in Figure 19 decorated the Fatimid western palace in the hall of Set Al-Mulk, his son Al-Aziz Billah Al-Fatimid and the sister of the Fatimid Al-Hakim bi-Amr Allah, who lived between 985 AD to 1021 AD, and this board contains many forms of Baa or Harby with other composite objects, which reflects the skill of the artist in the Fatimid era.

Reused in the decorations of the monumental architectural ensemble constructed by the Mamluk Sultan Al-Mansur Qalawun in Al-Muizz Street in the year 684 AH/1285 AD.

Another example could be found in Figure 20 depicting the Victoria and Albert Museum of a courtyard from the Fatimid era depicts the object of war clearly surrounded by floral motifs and the abdominal area decorated with Arabic semi-letters in the Kufic script characteristic of this stage, which is not any Arabic word, but only its purpose is decoration.

3.2. Harpy in Ayyubid Era

The majority of the animal painted vessels in the aforementioned museums exhibit bird themes, which are typically shown as duck, peacock, duckling, pigeon, eagle, crane, parrots, and roosters (Ghasemi & Ghasemi, 2020).

In addition, the epithet Saladin upon conquering Egypt and Syria, aimed to change the official Islamic cult throughout the country from Shia to Sunni, which was accompanied by the introduction of the Sufiism. The Sufists, however, considered all compound figures (combining two or elements, such as Harpy) as forbidden by sharia or haram. Based on that, we find diminishing examples of Harpy and all compound figures throughout the Islamic world at that period, as they treated each element as separate from another, and allowed no merge or conflation between plant, animal, and human figures (Abdel Rahim, 2000). This explains why we find rare instances of Harpy in Ayybuid era, followed by the Mamluk era in which Harpy figures almost disappeared.

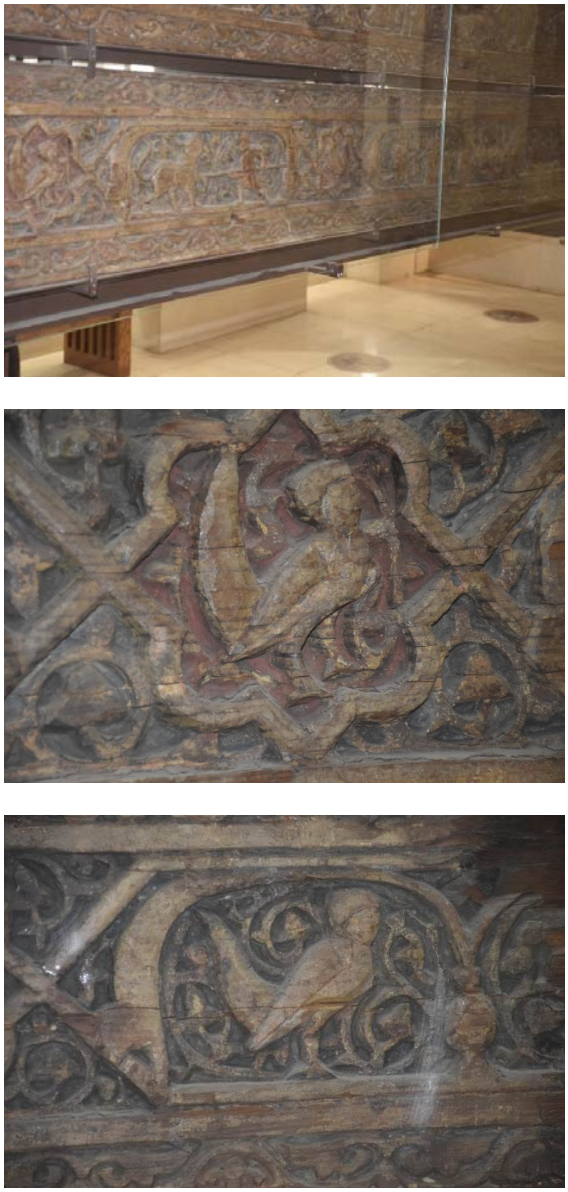

Figure 19. A wooden lusterware with engravings of human, plant, and animal compound shapes, including a harpy-like figure.

Figure 20. Harpy-containing ceramic lusterware at the Museum of Islamic Art in Cairo.

Pope also discusses how these animals look aboard ships: Harpies were drastically included into the pottery as soon as they had the necessary technique, whereas the phoenix or harpy is seen as a typical theme in the Islamic art of the twelfth and thirteenth century (Ghasemi & Ghasemi, 2020).

He also described the role of this motif in the vessels like shown in **Figure 21** as follows: "In these vessels, there is a large figure painted on a simple background surrounded by motifs of flowers and bushes". In most cases, the edges of the vessels have a strip of Kufic script (common decorations in vessels painted on Raqqa liner glaze). Apart from the difference in technique, these vessels are very similar to the enamel dishes painted on Iranian glaze in terms of the iconography. The species that was first recorded in the 1180s, shows that Syrian potters were inspired by Persian pottery of that period (Khalili & Group, 2005: p. 229). This motif's link to magical ideas is another point of connection. Irwin claimed that although painters, potters, and metalworkers employed the harpy motif, it was unclear whether they did it for amusement or because they had an interest in odd and fantastical artefacts. But the idea of a harpy also conjures up joy (Ghasemi & Ghasemi, 2020).

3.3. Harpy in Mamluk Era

According the question about the use of Harpy's figure in the context of Tree of Life on pottery and metallic containers in fifth to eighth century A.H (eleventh to fourteenth century A.D), this hypnosis can be proved that Harpy's figure in Islamic period is used not only as a decorative pattern but also as a way of expansion of Islamic Sufism and development of Sufism theories in this period; ancient concepts were effective factors in the presence of these symbols on works of art. It seems that the application of Harpy's figure or "Human-Bird image" is associated with Sufism concepts related to freedom of soul from body as its prison, flying to human's real place and reaching to the perfect human being degree, but the personification in the forms of Harpy was considered Haram or unlawful by the Sufists; therefore, no Harpy-containing figures are found in the Mamluk era. It is crucial to note that the Harpy in Egypt and Syria has completely disappeared and was ended by the time of the Mamluk era, as Mamluks considered it to be Haram.

Figure 21. Dish. A Seren in low relief under coloured glazes. Made of blue, green, manganese-purple glazed and incised pottery.

3.4. Harpy in the Andalusia

As Harpies were prevalent in Roman and Byzantine art, and they first appeared in Andalusia across the Byzantine churches as a form of art, the Harpies were introduced to the Western Islamic world through Egypt through the Roman occupation at the time. In Andalusia's Islamic civilisation, harpies also made their appearance (Barrucand & Bednorz, 2007). Harpies add the tail of a snake or scorpion to the feminine face and the bird body of mermaids, as shown in **Figure 22(b)** and **Figure 22(c)**, despite the fact that they are often connected with bird-mermaids due to their function in winged emblems. Harpies are sometimes seen in pairs, with their bodies connected and their heads twisted in a menacing manner. It is a threatening or aggressive stance that may be influenced by an improved adaption to the support as well as the oriental impact on the compositions organized around an axis of symmetry. In addition, they can be presented headdresses with a Phrygian cap (Barrucand & Bednorz, 2007).

(a) (b)

(c) (d)

Figure 22. (a): Capital with harpies facing each other. Cover of church of San Martín de Artaiz. (b): Harpies on the sides of a stem that tangles in their necks. Capital of the west gallery of the cloister of Santo Domingo de Silos. (c): Harpies with Phrygian cap on the backs of lions. Capital of the arcaded gallery of San Pedro Apostol. (d): Balaguer: Information about the decoration in the stucco. An early Islamic castle near Balaguer, which is thought to have existed between the ninth and the middle of the eleventh century, still has a considerable portion of its wall and towers standing. The forces of Merida are compared to the cut-stone wall, which consists of single, double, and triple stretchers and headers in an arbitrary rhythm. For instance, a Harpy may be seen inside a leafy tendril in the left picture (Barrucand & Bednorz, 2007).

The harpies are usually shown in the colossal sculpture found in the capitals, corbels, and other architectural features of Romanesque buildings, as shown in Figure 22(a). The harpies that emerged in the plasterwork of the vaults of the San Fernando cloister of the Royal Monastery of Las Huelgas de Burgos are just one of the later instances we have like shown in Figure 22(a). Additionally, it has been feasible to identify its presence in ceramic and eboraic artefacts, texts, and engravings. Later illustrations combine the harpies' and the bird-representations. mermaid's In Formo's fortress, which was constructed in Balaguer (1040-1045) during the Spanish Islamic Middle Ages, as shown in Figure 22(d), harpies may also be seen (Barrucand & Bednorz, 2007).

3.5. Harpy in the Seljuk Empire

In the Eastern side of the Islamic world, Harby appeared clearly in the arts of the Seljuk empire, but they did not only draw it on dishes or carve it on wood, but they made its own statues, such as the ancient Greek civilization, and transferred it to Turkey directly during the ancient Greek occupation. For example, these figures with harpies were generated out of the existing figural repertoire as in Figure 23, especially from those, which are regarded as powerful or virtuous such as Figure 24. The most common mythical creatures in the Seljuk empire were the simurgs and harpies as in Figure 25. Figure 26 also shown that harpies existed in potteries such as ceramic of a blue and white glazed, or in pottery alabastron decorated with harpies such as Figure 27.

Figure 23. Reconstruction of a tile panel with depictions of various animals, simurg and human figures. from Great Palace in Kubadabad, Konya.

Figure 24. Bowl with harpies and seated figures, Mina'i ware, Central Iran, Seljuk period, late 12th century AD, earthenware with polychrome enamels over a white glaze and colors - Cincinnati museum.

Figure 25. A Large Intact Kashan Underglaze-painted moulded pottery pouring vessel in the form of a Harpy. Persia, AD 1150-1220 and colors.

Figure 26. Seljuk, Kashan. A beautiful ceramic of a blue and white glazed "harpy". Nice and delicate facial features with porous and slightly faded patina.

Figure 27. Pottery alabastron decorated with a harpy to left, with outspread wings. Found in the British Museum. Item number 1877, 0930.6.

3.6. Harpy in Ottoman Era

The Ottoman Empire (1299 AD until 1922 AD) was distinguished by the Iznik Ceramics, in which harpies were continued to manifest themselves as a prominent artistic representation. Harpies manifested in the Ottoman arts in Iznik, perhaps because it was a common art in the Seljuk state and the subsequent Mongol occupation of the region, so it remained present until the middle of the Ottoman Empire, although it seems completely cut off from the original impregnable Egypt, so no traces of it were found in the Mamluk state (Gökçe, 2018).

Iznik has always been an important centre of ceramic art creation. Iznik gained notoriety when the Ottoman Empire was established in the 15th and 16th centuries as a result of the expansion of the ceramic industry (Gökçe, 2018). Iznik ceramics are a magnificent technological accomplishment in Turkish ceramic art history. The finest examples of Ottoman ceramic art were the Iznik vessels and tiles, which combined Ottoman design elements with those from China, Asia, the Balkans, and even Europe. The palace's support for Iznik's pioneering pottery industry encouraged and nurtured its expansion. This study describes the peculiar Iznik ceramic production and decorative features that may be found in various literary sources (Gökçe, 2018).

Additionally, harpies were frequently found in Iznik pottery and ceramics like in **Figure 28** and **Figure 29**. Some of the last remnants of Harpy have been discovered in Iznik, under the Ottoman era in dishes such as **Figure 30**. Some of them, including the following images, may be seen at the British Museum.

Figure 28. Bottle. Grotesque animals, harpies and gambolling lions, bull's head, flutes, frieze of quails and cable band.

Figure 29. Bowl. Two pairs of harpies, tubular dragons, phoenixes and grotesque animals, lion, hyena, pig.

Figure 30. Dish. Wheel marks. Lobing and wave and rock scroll at rim, central medallion of harpies with central flower vase.

3.7. Harpy Decline in Renaissance Era

The emergence of Al-Harbi continued significantly until the Renaissance, particularly through the Iznik as the gateway of this forms of art, and perhaps the reason for its creation to this period is its expression of different concepts such as expressing evil and good at the same time, or perhaps for its beauty as a decoration or ease of painting as it appeared in some paintings, or perhaps for other reasons that we do not know were in the reason for its spread until the Renaissance, and these are examples of its appearance in the Renaissance in different countries. The trade in ceramic manufacturing between Italy in Europe and the Islamic world, as represented by Iznik in Turkey, flourished and gained shape with the appearance of a distinctive style of ceramic plates with Italian tradition in Iznik (Zidan, 2019). Around 1500-1530 A.D., Tondino dishes, a sort of ceramic plate, were popular in Italy. Similar examples were also manufactured in the modern era by Iznik workshops (Zidan, 2019). Therefore, examples of harpy started to become less pronounced such as in **Figure 31** and **Figure 32**, or very pronounced but rarely present such as **Figure 33**, and **Figure 34**. Only in the museum of Rome, one sees the remaining figures containing harpies such as **Figure 35** and **Figure 36**.

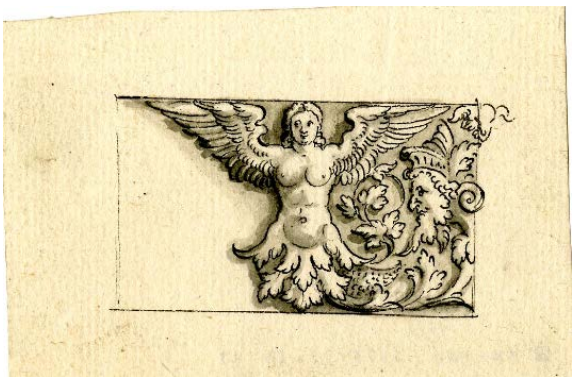

Figure 31. In British Museum. Ornamental panel with a harpy and a mask, one of several sheets inserted in "A Jeweller's Pocket Book" Pen and black ink, with grey wash.

Figure 32. Alder box, covered with gesso, gilding and white lead pastiglia, Venice, ca. 1510. Decorated covered lid with confronted harpies. In Victoria & Albert museum.

Figure 33. In British Museum. Figure in lead-glazed earthenware of a harpy seated on a four-lobed oval base, maker unknown, made in Staffordshire, ca. 1780-1790.

Figure 34. In British Museum. A harpy approaches from the right, to steal food from a table, while King Phineus sits looking away, to the left; finished proof. 1896.

Figure 35. The Four Part Being with human head and bird body, the museum of Rome.

Figure 36. The four Pedestals (c. 1461-1466), made of marble showing harpies on four corners, designed by assistants of Donatello, the museum of Rome.

Iznik pottery was influenced by Chinese porcelain in the first half of the 16th century A.D. in terms of colours (blue and white), Italian maiolica in terms of forms (such as "tondino" plates), and harpies as well. Additionally, although they were not utilised in figurative settings, Italian figural portraits were included into the creation of Iznik ceramics, featuring complex forms like Harpies. We find over-glazed and under-glazed figures of Harpy common in the renaissance era. Below are some examples of Harpies found during renaissance.

4. Conclusion: The Purpose behind Human-Headed Bird Figures

The purpose of this paper was to investigate the notion of the human-headed bird in different eras to stand upon its depiction and symbolic representation in each era presented. Overall, the results showed a high diversity in the depiction and representation of the human-headed bird imagery throughout different eras, suggesting a clear development of the notion of Ba to Seren to Harpy. Our investigation has revealed that Islamic literary tradition and folklore acknowledge that the Harpy creature had its own literary tradition, each more or less independent of the other era. Although the motif of a human-headed bird in Islamic art may have been thought to signify a single fantastic creature, however, these traditions share a few characteristics.

Furthermore, it has been shown that the Muslim artist used a single common type to depict these four animals in pictures, which is roughly based on the decorative arts figure of the time. One seeks in vain for any characteristics that might distinguish a specific Harpy creature, such as a beak, claws, bulges on the neck or chest, a scared demeanour, and so on. The creature shown is none other than the man-bird (harpy), and the illustrator paid little to no regard to the finer points of the literary works they accompanied.

They merely supplied the picture of a bird with which they were familiar in the decorative arts in order to illustrate any of the human-headed birds of Muslim folklore. The crowned heads, pearl diadems and necklaces of the birds and the voluted tips of their wings are a part of the Islamic heritage as in the case of the Islamic sphinxes are a mere representation of that folklore. Furthermore, compound figures such as sphinxes and harpies due to combining human-bird personifications and body-soul metaphors, have been frequently used in magic to conduct magic-related rituals, as it was believed to possess supernatural powers that are divine in nature, since the concept of harpy goes back to the Greek mythology that incorporated the personifications of gods.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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The Egyptian Pyramids—Connection to Rain and Nile Flood Anomalies

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Abstract

This paper explores rain and Nile flood anomalies observed in Dynastic Egypt. It builds upon the meticulous analysis and documentation initially conducted by esteemed archaeologist Karl Butzer, whose findings constituted a foundational basis for subsequent research in this field. Barbara Bell further expanded upon Butzer's work through extensive research published in the 1970s. Additionally, James Allen and Malcolm Wiener have made contributions to the discussion of weather anomalies through their respective work. Drawing from the expertise and established facts derived from these studies, this paper puts forth a hypothesis to elucidate these weather and rain anomalies. It proposes that a combination of religious practices and pyramid function related to rainmaking played a significant role in influencing climatic conditions. The notion of the pyramids influencing weather takes its roots in the work of esteemed physicist Charles Wilson. To support the claims, the paper presents experimental results that provide empirical evidence. Finally, the paper concludes by presenting historical evidence that bolsters the proposed hypothesis, leveraging the facts about Egyptian civilization and its practices.

Keywords

Ancient Egypt, Heb-Sed, Naqada III, Old Kingdom, Pyramids, Maat Offerings, Rainfall, Nile Floods, Famine, Tempest Stela, Sphinx, Blue Lotus

1. Introduction

The Heb-Sed festival stands out as one of the most prominent and potentially the most ancient festival in ancient Egypt. This festival served as a demonstration of the king's vitality and potency, although certain aspects of its origin and specific details remain unclear. There is a belief that the festival tested the king's

vital power and if unsuccessful, the king would be sacrificed and replaced by a more potent successor.

The Heb-Sed ceremonies have been the subject of extensive excavations conducted over the years, revealing valuable insights into this ancient Egyptian tradition (Uphill, 1965). It is widely acknowledged that these festivities occurred thirty years after the king's accession to the throne, although certain rulers deviated from this pattern and held them more frequently. Our current understanding of the Heb-Sed ceremonies however primarily stems from artifacts dating to the later period of Egyptian civilization, as in example of the temple in Bubastis, which emerged at least two thousand years after the probable inception of the festivities (Naville, 1892). Consequently, our knowledge may not precisely reflect the original process or purpose of the festival. Prominent Egyptologists, including Sir Flinders Petrie, have postulated that the initial motivation behind the Heb-Sed ceremonies possessed an agricultural context with the primary aim of invigorating rejuvenation in the fields of ancient Egypt (Petrie, 1925: p. 65). Although it is believed that King Namer was the first to introduce this festival, its origins potentially extend back to an even earlier period preceding the establishment of dynastic rule (Wilkinson, 1999: p. 212).

During excavations near the Khufu's pyramid causeway in Giza, Selim Hassan discovered a small stone fragment that appears to indicate a connection between the Heb-Sed festival and Khufu's pyramid (Hassan, 1960: p. 23). Unfortunately, due to the fragment's size and the fragmented text, the specific details could not be deciphered. Nevertheless, this finding holds significance as it suggests a link between Khufu's pyramid, Giza necropolis and the festival. It is intriguing to hypothesize on the nature of this connection. Could the ritual sacrifice of a feeble king still have been in practice at that point, leading to the death of King Khufu? Alternatively, could Khufu's substitute have been sacrificed? (Hassan, 1960: p. 24) Or perhaps, a ritualistic slaughtering of a bull took place. Further research, exploration, and analysis of additional archaeological evidence will be crucial in unraveling the mysteries surrounding the Heb-Sed festival and its connection to Khufu's pyramid. It is, however, safe to say that if King Khufu died at such event, his body would be destined for the Great Pyramid of Giza.

The details surrounding the burials and rituals of kings in the Old Kingdom of Egypt remain elusive, with limited concrete evidence to provide definitive answers. We can draw educated conclusions, however, and contemplate based on available information. A glimpse into burial customs before the Old Kingdom comes from a burial depicted in **Figure 1**, which dates to the Naqada III period, a few centuries prior to Khufu's time. In this image, a deceased individual is shown placed in a coffer along with jars containing provisions for the afterlife. While this provides a possible insight into burial practices of that earlier period, it does not guarantee that the same customs were followed in the Old Kingdom for king's burials.

Regarding the pyramids, which clearly have a funerary context, it is unclear whether they served as eternal tombs for kings or merely as temporary stops

Figure 1. Naqada III burial c. 3000 BCE, showing provisions added to the interior of the coffer along with the deceased individual.

before a more elaborate and appropriate burial for eternity would take place. The evidence is limited, and we are left to speculation. One perspective on this matter comes from Sir Wallis Budge, a prominent Egyptologist, who believed that looking at the customs of Western African tribes could help to gain insight into the burial rituals of the Old Kingdom (Budge, 1911). Budge argued that such isolated African tribes maintained their traditions with minimal external influence, potentially providing clues to how the Old Kingdom might have functioned in terms of religion and burials. Budge pointed out that certain Western African tribes employed a two-phase burial process, where the first phase served a specific objective or function, and it was followed by a more elaborate second phase at a later time for eternity. Budge and Petrie identified evidence suggestive of such practice in Naqada III burials as well, as seen through Petrie's excavation work (Budge, 1911: p. 171). Moreover, the discovery of two dates within the tomb of Queen Meresankh III further supports the notion of two phase burial process in the Old Kingdom (Reisner, 1927: p. 74). One date in her tomb corresponds to what the dynastic Egyptians referred to as the "resting Ka", while the other indicates the departure to the eternal tomb. The specific purpose of the "resting Ka" stage, however, within this complex burial process remains uncertain.

One approach to exploring the topic of "resting Ka" and its function is to formulate a well-grounded hypothesis. This can be accomplished drawing on the research work of Barbara Bell published in the American Journal of Archeology. Bell argued that a key responsibility of a reigning king in ancient Egypt included rainmaking (Bell, 1970, 1971, 1975).[1] According to this perspective, the king had a crucial role in ensuring the prosperity of the cultivated Egyptian lands by controlling rainfall through his purported magical abilities. It was believed that the

[1]A similar proposition was put forth by Gerald Wainwright in his book "The Sky Religion in Egypt; its antiquity & effects" (Wainwright, 1971).

king possessed the power to make the banks of the Nile valley and even the desert wadis green (Allen, 1988: p. 41). Extending this line of thinking, when the king died, he was believed to continue his caring role, though in a different capacity as a great god in the afterlife, where he would still oversee rain, crops, and Nile levels (Frankfort, 1978: p. 59). Meanwhile, his successor Horus, inheriting the role of his predecessor, fulfills his caregiving obligations upholding the principles of Maat, the fundamental principle of the world order (Teeter, 1997), where the integral part of Maat is offering rituals to the gods, which was believed to be essential in retaining the divine oversight and protection (Assmann, 2001: p. 5). It was believed that upholding Maat, a pharaoh could restore the Egyptian land to its primordial time (Teeter, 1997: p. 9), evoking the imagery of a land flourishing with abundant rainfall. Therefore, it seems conceivable that there exists a connection between "resting Ka", rainfall, and Maat.

The connection between the deceased king and rainfall receives additional support from the writings of Plutarch, a renowned philosopher from the first century. It is widely recognized that the deceased king is associated with the deity Osiris, who is not only the god of the dead, but also holds significance as an agricultural god. According to Plutarch, Osiris is linked to all germinating moisture (Plutarch, c.100, 1936: p. 81), which can be seen as a reference to rain. Furthermore, Osiris is associated with Nile floods and vegetation (Breasted, 1912: p. 23). The ancient Egyptians believed that only by performing the prescribed offering ceremonies correctly and at the right season could the Nile rise to the appropriate level to water the lands (Budge, 1910: p. 172). They also believed that cutting back on offering would result in famine throughout the land (Assmann, 2001: p. 64). Consequently, based on this association, one could interpret that there is indeed a link between the deceased king, offerings, and rainfall. Before scrutinizing this connection, it would be beneficial to examine certain elements of rain.

Rain Science

In 1895, Charles Wilson, a physicist, meteorologist, and Nobel Prize winner, made a groundbreaking discovery: he proved that rain could be artificially created. His research demonstrated that when air is subjected to an influx of electrically charged particles, condensation forms around these particles. If the accumulated water reaches a critical mass, it falls to the ground as rain. Fast forward to the twenty-first century, and we now have a plethora of academic institutions, funded research programs, conferences, and publications dedicated to advancing and perfecting this technology. Additionally, various businesses have emerged, offering rain enhancement products specifically designed for arid regions across the world.

One notable example is Meteo Systems Corporation, headquartered in Zurich. Over the past 15 years, this company has successfully provided rain enhancement services, resulting in 52 instances of rainfall in the Abu Dhabi desert. Meteo Systems achieves this by utilizing structures similar to tall towers, equipped with apexes that emit electrically charged particles. These particles are subse-

quently carried by the wind, covering a larger area and stimulating condensation, ultimately leading to rainfall.

One intriguing question remains unanswered: Can pyramids generate similar charged particles, leading to rainfall, constrained by well-established facts about the ancient Egyptian civilization? I will explore the details shortly, but first, let me summarize the hypothesis.

2. Hypothesis

1) A deceased king, along with jars containing provisions for the afterlife, is placed inside a coffer within a pyramid, drawing inspiration from the burial practices observed in the Naqada III, as depicted in **Figure 1**.

2) The jars contain beer, bread, grain, ox, and sweets, which are specifically listed in the Pyramid Texts as sustenance for the king (Allen, 2005: p. 326).

3) Once the king's body is laid to rest inside the coffer, it is hermetically sealed. Budge confirms that this sealing practice was indeed employed (Budge, 1925: p. 421).

4) The provisions within the jars undergo fermentation, where yeast converts the sugars present in food into carbon dioxide, water, or ethanol. This process can occur within a sealed coffer with no air intake, as long as the necessary conditions for yeast growth are provided. Some studies have found that fatty acids present in ox meat are essential for sustaining this growth (Tehlivets, 2006).

5) Due to the hermetic sealing, the carbon dioxide produced cannot escape, leading to the buildup of gas pressure inside the coffer. This pressure exerts mechanical stress on the coffer, which is made of Aswan granite containing at least 40% quartz. Quartz is known to possess piezoelectric properties, meaning that its crystal lattice generates electrically charged particles when deformed. The more significant the pressure on the quartz, the more charge is produced (Rosen, 1992: p. 36).

6) The produced negatively charged particles move through the moist limestone core of the pyramid towards the apex, where they accumulate and ultimately emit. The pyramid's shape is particularly conducive to the collection and emission of charged particles (Wilson, 2019: p. 410).

7) The emission of charged particles contributes to the formation of rain clouds, following the process introduced by Charles Wilson. It is worth noting that numerous cultures worldwide have traditionally associated quartz with rainmaking (Buchler, 2011: p. 34).

8) The rain clouds possess their own voltage potential. If the voltage potential from the cloud to the pyramid apex exceeds 3000 Volts per mm in the interface between the capstone and air, a corona discharge light will appear at the capstone, which in air has blue and purple signature.[2]

9) The reigning king upholds Maat, performing periodic offerings to the gods. These offerings include physical nourishment such as food, beer, bread, and

[2]For reference, a typical 5 mm quartz crystal inside a typical butane lighter creates about 15,000 Volts when a trigger knocks on the quartz crystal.

drinks (Teeter, 1997: p. 78).[3] I hypothesize that these items are periodically replaced inside tightly sealed coffer.

10) At one of the final steps, the king is removed from the coffer and the pyramid, dried in natron per process outlined by Herodotus, wrapped in clean strips of linen along with amulets, jewelry and buried in a mastaba or underground tomb more suitable for the eternal hereafter.[4]

With the aim of providing empirical support for several claims put forth in the hypothesis, a series of experiments was conducted. Specifically, the focus was on exploring the production of electrically charged particles resulting from the application of stress on granite with ferment. The following sections will present and discuss the experimental outcomes derived from these investigations.

3. Experimental Results

The experimental configuration was devised with the objective of preserving essential elements of Egyptian pyramid. In this regard, the Khafre's pyramid was employed as a point of reference for designing the setup. Khafre's pyramid has only one chamber that features a granite coffer embedded into the floor. Additionally, the pyramid consists of limestone blocks, stacked in a structure. The structure extends to a height of approximately 143.5 meters and has a base length measuring 213 meters (Lehner, 1997: p. 122). The key objective of the test to prove that granite material, stressed by ferment, hermetically sealed inside the container, produces electrically charged particles.

The experimental setup is shown in **Figure 2**. In this setup, a granite container is embedded into a masonry. A sensor made of copper foil is attached to the surface of the masonry. The purpose of the sensor is to detect and measure the charged particles generated inside the granite container. The output from the sensor is then connected to an acquisition system for data collection and analysis. The acquisition system employed in this setup utilizes an electrometer amplifier, specifically the Analog Devices ADA4530-1. This amplifier has a very large input impedance and allows for accurate measurement of the charged particles detected by the sensor. The acquired data is recorded using a USB oscilloscope, the PCSU1000, and a PC running PSG data logger software. To minimize electric noise interference, all electronic equipment used in the experiment is disconnected from switching power suppliers and powered by batteries. This precaution ensures that unwanted external electrical signals do not affect the measurements. In addition to the sensor and acquisition system, a pressure gauge is integrated into the experimental setup. The pressure gauge is connected to the interior of the granite container, enabling the measurement of pressure

[3]This belief is exemplified by the quote "That which you eat is Maat, your drinks are Maat, your bread is Maat, your beer is Maat" (Teeter, 1997: p. 78).

[4]Sir Wallis Budge held a belief that Dynastic Egyptians were pragmatic and had practical reasons be-hind their processes and rituals (Budge, 1911: p. 123). Building upon this perspective, it is plausible to contemplate that the original purpose of mummy wrappings could be to preserve and contain all body parts within a single piece of wrapping, ensuring the body's integrity during its journey from the pyramid to the eternal burial site.

changes inside during the test. Furthermore, a pressure relief valve is incorporated for safety purposes. This setup does not have limestone blocks stacked over the container. It can be reasonably inferred, however, that negative charged particles produced inside the container would collect at the apex of the stone structure through the Coulomb's law (Ling, 2021: p. 190).

The overall configuration of the acquisition system and experimental setup, including the granite container, masonry, sensor, electrometer amplifier, USB oscilloscope, PC, pressure gauge, and relief valve, is depicted in Figure 3.

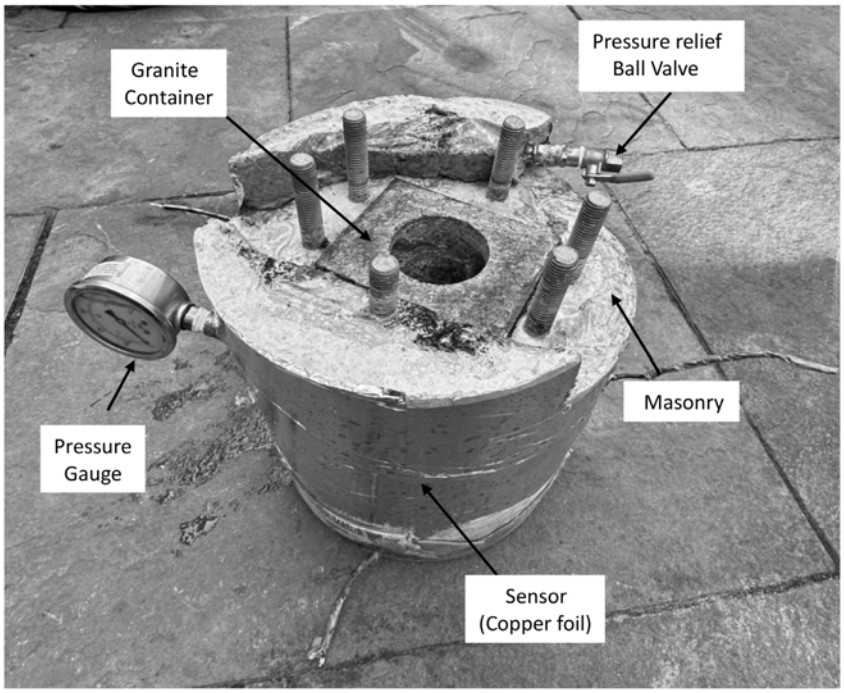

Figure 2. System under test. Granite container and instrumentation.

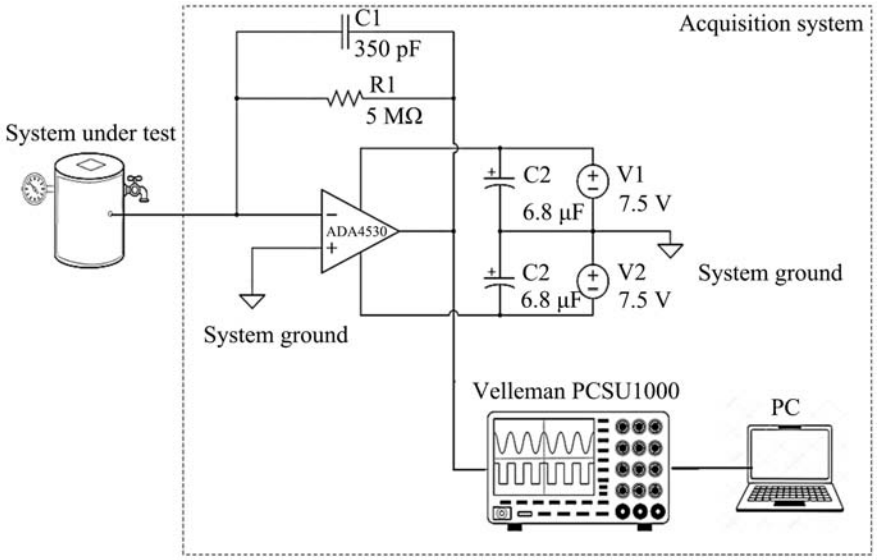

Figure 3. Acquisition system.

In the experiment, a solution was prepared by thoroughly mixing water, yeast, and sugar in specific quantities. The solution consisted of 0.7 liters of water, 2.66 ounces of yeast, and 6 ounces of sugar. This solution was then added to the granite container and hermetically sealed using a contraption installed in the masonry.

Figure 4 presents the experimental results obtained from this setup. As the yeast initiates the conversion of carbohydrates to carbon dioxide, the pressure within the container gradually increases over time. After 320 minutes, the pressure inside the container reaches 300 pounds per square inch (psi). The pressure relief valve is open at the 300 psi mark, releasing the excess pressure from the container. The surge in electrical charge associated with the opening of the pressure relief valve is captured and illustrated in Figure 5. The notes mentioned below elaborate on further observations, findings, and interpretations.

Notes:

1) In the initial 320 minutes of the experiment, the sensor did not capture any charge. However, this result should be interpreted cautiously. The sensitivity of the acquisition system may pose a limitation, as more charge may be dissipated through parasitic leakage paths in the setup than actually generated by the granite container. Previous research by Yoshida (Yoshida, 1997: p. 14885) supports the notion that charge carriers are generated by the granite during this phase. In the case of the actual pyramid, these charges have limited pathways, resulting in their accumulation at the pyramid's apex.

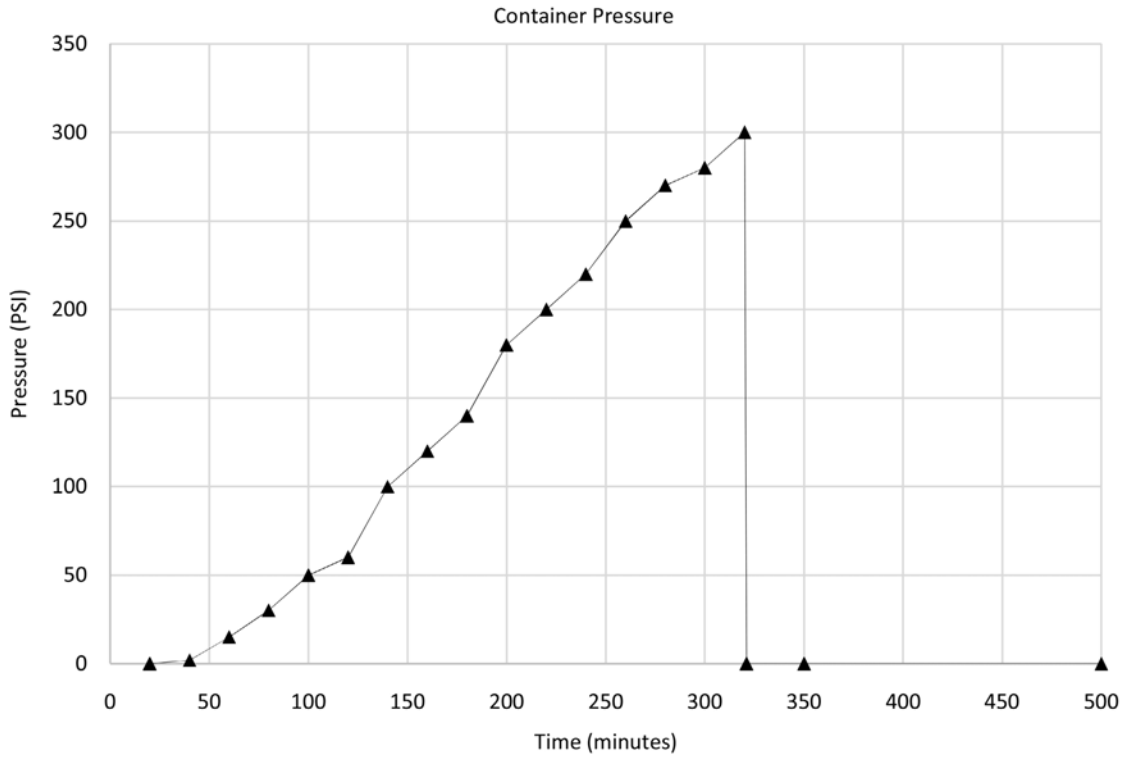

Figure 4. Granit container pressure measurement data.

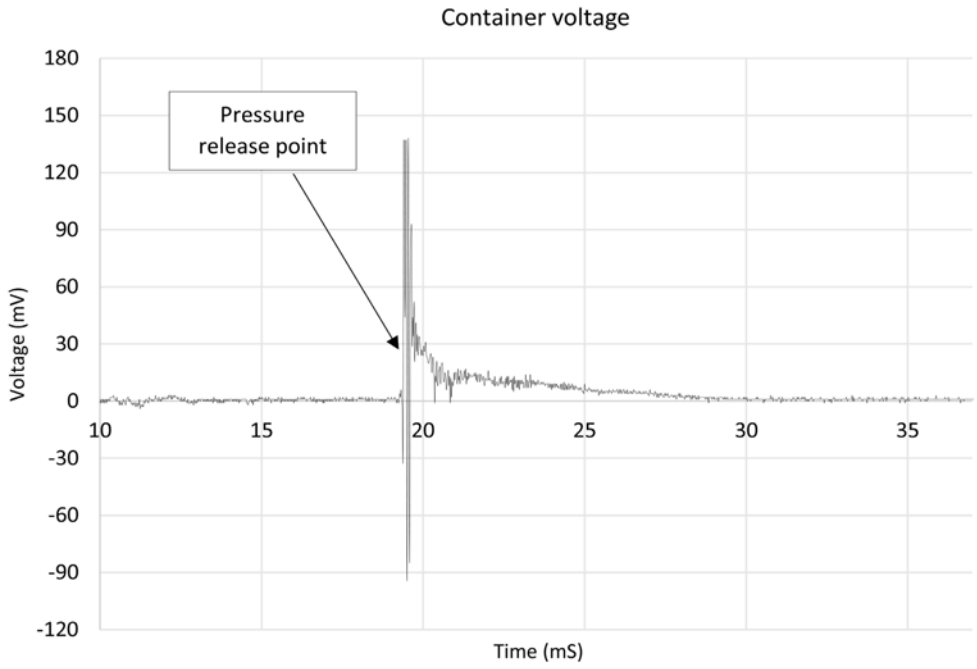

Figure 5. Granite container sensed voltage.

2) The granite material used in the experiment belongs to the category of rose granite. Although visually similar to Aswan granite, these two types of granite have different compositions of quartz crystals, distribution, orientation, and size. The properties of other components that make up the rest of the granite also differ. The presented results, however, are expected to be fundamentally similar regardless of the specific granite material used.

3) The experiment was conducted up to a pressure of 300 psi due to safety considerations and other factors. This pressure level is only about ten times higher than that of car tires. The effect of the experiment is anticipated to be more pronounced at higher pressures, as typical granite materials can withstand pressures at least 200 times greater pressure than what was employed in the test. Furthermore, enhancing the setup by implementing a socketing technique, similar to the design of the granite coffer in Khafre's pyramid, may further enhance the granite stress limit.

4) It is essential to note that the size of the granite container utilized in the experiment is small compared to a typical granite coffer found in Egyptian pyramids. The dimensions of the granite container in the test were 4" × 5" × 8", with a cavity volume of 0.7 liters, which is comparable to the volume of a large coffee mug. As a point of reference, the dimensions of Khafre's coffer are 41.9" × 38.12" × 103.6", with an inside volume of 1096.5 liters (Petrie, 1883: p. 107). Therefore, the scale of the test container should be considered when extrapolating the results to larger coffer size.

5) It is important to reiterate that the setup, from the sensor to the computer, is solely dedicated to data acquisition. No devices are included in the setup to actively add to the electrically charged particles. The purpose of the data acquisi-

tion setup is to capture, process, filter, display and assess the particles produced by stressed granite.

6) Although efforts were made in the test setup to minimize charge leakage, it is unfortunately unavoidable. Charge carriers can leak through air, wires, printed circuit board materials, or internal parasitic paths of the electrometer amplifiers. Due to this, it can be inferred that the amount of charge produced in the granite is likely higher than what was detected with the experimental setup.

7) The study of granite under stress and its production of electrical charges is not a novel field. Numerous publications have explored these properties of granite since at least the 1950s. Some relatively recent works examining this phenomenon can be found in the references provided by Yoshida (Yoshida, 1997).

8) In order to seal the ferment inside the container, a contraption including steel bolts was embedded in the masonry. It is important to note that such materials would not have been available during the Old Kingdom era of the pyramids. However, it can be hypothesized that limestone blocks stacked on top of the coffer lit, pressed against the ceiling, may have been used for a similar purpose. This would be in addition to cementing the lid to the coffer box. **Figure 6** provides a visual representation of how it was likely done in the Serapeum. Additionally, it is worth mentioning that limestone blocks have been found inside some of the pyramids in chambers, the purpose of which has not been fully explained (Hamilton, 2020: p. 31).

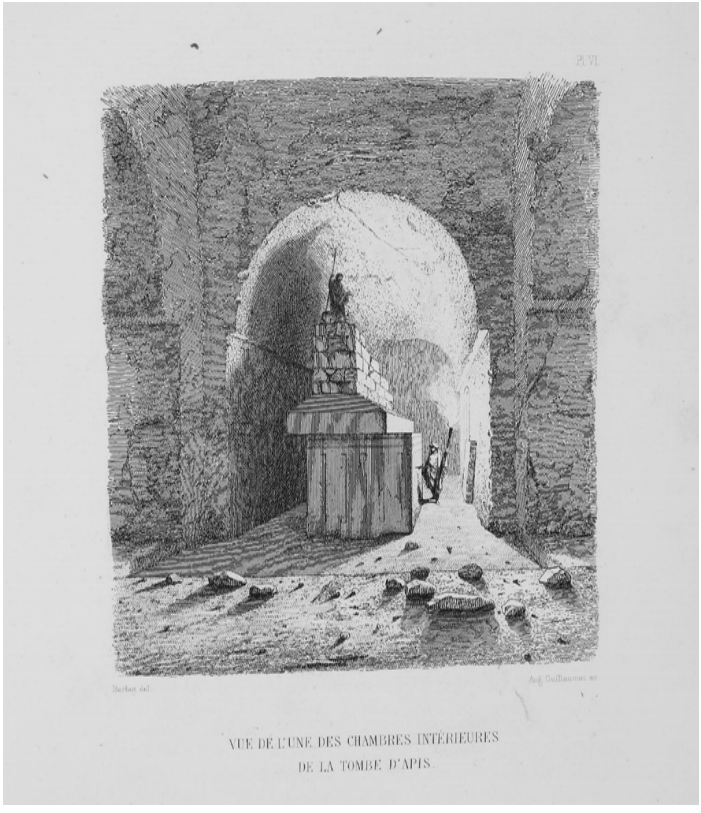

Figure 6. Serapeum of Saqqara, showing stone blocks piled on top of the lid of the granite coffer (Mariette, 1856: Pl. 6).

9) It is proposed that the emission of charge carriers from the apex, a process that occurs at ambient temperature, will result in the generation of rain clouds. Should this voltage potential from the apex to the cloud exceeds 3000 Volt per mm at the apex, a visible corona discharge light will be observed at the pyramid's apex.

10) Referring back to the experimental results presented in **Figure 5**, it is evident that there is a surge of charge carriers associated with container pressure relief. The reason for this surge is the significant stress change experienced by the quartz, relaxation and charge built as a result.

11) Upon further reflection, it is postulated that within the actual coffer found in the pyramid, there would come a point when the pressure built up inside the coffer surpasses the weight of the stone blocks stacked on top of the lead or cemented material, thereby propping up the lid, and releasing the pressure. This particular characteristic may be the key in the pyramid as the charge generation is the greatest at such event.

4. Evidence

Once the mechanism behind how the pyramids could potentially generate rainfall has been explored along with the experimental evidence, it becomes worthwhile to examine historical evidence supporting this proposition. By considering the historical evidence in conjunction with scientific exploration, experimental validation and cultural understanding, we can develop a well-rounded perspective, reinforcing the connection between the pyramids and rain.

4.1. Evidence 1—Famine Stela

The Famine Stela from the island of Sehel, recounts a seven-year drought during the reign of the third dynasty pharaoh Djoser (Budge, 1994: p. 60). Although the stela itself is a reproduction of an older text, the story line is what carries significance. According to the stela, the gods were angered by the Egyptians' lack of worship towards the Nile gods, leading them to unleash a prolonged period of aridity and insufficient Nile floods. To investigate this matter, Djoser sends Imhotep, who consults older records and discovers that floods are controlled by the god Khnum-Khufu, residing in Elephantine. As a response, Djoser reinstates offerings to the Nile gods, resulting in the drought ending, the Nile returning to its appropriate level, and bountiful agriculture and crops.

Two noteworthy points emerge from this evidence. Firstly, the story establishes a clear link between rainfall and offerings to the gods. It is hypothesized that Djoser likely made Maat offerings, which then allowed nature to respond accordingly. Secondly, the knowledge of the rainmaking practice seems to have been forgotten at Djoser's time. As Imhotep, himself, needed to align with older records to recover the knowledge. The question is then, when was this originally devised?

It is quite enticing to attribute this innovation to the era of the 1st Dynasty ruler, Den. This inclination arises due to several compelling factors. Firstly, the

Palermo stone, which records the lineage of kings, also includes measurements from a Nilometer (Bell, 1970: p. 571). These measurements reveal a significant anomaly during Den's reign, depicting higher Nile levels compared to the periods before and after his rule. Moreover, Den's Horus name, which is one of the earliest among the five names with a serekh façade, is bestowed upon the king posthumously (Petrie, 1888: p. 22). Notably, Gardiner suggests that Den's Horus name, "Udimu", can be translated as "water pourer" (Gardiner, 1961: p. 401). It is plausible to pressume that Den's recognized role in procuring rainfall and higher Nile levels left a lasting impression on his followers, leading them to confer upon him the appellation of "water pourer". This could indicate the recognition of his association with precipitation and his perceived ability to influence favorable weather conditions.

4.2. Evidence 2—Tempest Stela

The Tempest Stela, which recounts a devastating storm that occurred during the reign of Ahmose I, a pharaoh of the 18th Dynasty, has captured the attention of scholars and Egyptologists. This historical artifact describes an unprecedented calamity that ravaged Egypt, resulting in the destruction of temples, pyramids, and the loss of many lives. The stela, restored and translated in 1967, has since sparked various interpretations and scholarly discussions among experts in the field. Among the interpretations put forward by renowned scholars, Malcolm Wiener and James Allen propose that the storm described on the stela, although undoubtedly extraordinary, was a natural event (Wiener et al., 1998). On the other hand, Ritner, Foster, Moeller, Vandersleyen, Goedicke, and Davis, suggest that the calamity depicted on the stela might be attributed to the eruption of the Thera volcano, which is believed to have occurred around the same time as the events described (Ritner et al., 2014). Additionally, Ryholt and Manning offer an alternative perspective, suggesting that the inscription on the stela may be a metaphorical narrative inspired by the Hyksos invasion and the destructive force they brought (Manning, 1999: p. 196).

Each of the aforementioned proposals is not without its flaws, as pointed out by the authors cited above. For instance, Ritner argues that the magnitude of the storm described is too extraordinary to be attributed to a natural weather event (Ritner et al., 2014: p. 7). Additionally, Wiener suggests that the geographical distance between the Thera eruption and Egypt undermines the possibility of such a catastrophe being caused by the eruption alone (Wiener et al., 1998: p. 23). The misalignment between the dates of the Thera eruption and those inscribed on the stela, as noted by Wiener, weakens the direct connection hypothesized by Ritner (Wiener et al., 1998: p. 23). Moreover, the absence of the Hyksos name on the stela, which Ryholt attributes to the scribe's hesitation or feelings of humiliation, is regarded as a weak argument by Ritner and his colleagues (Ritner et al., 2014: p. 12). Importantly, it should be emphasized that the storm, as documented on the stela, affected the entirety of Egypt rather than just a localized

area. Furthermore, as Ritner asserts, the prolonged duration of the storm could possibly extend to an unprecedented twenty nine days (Ritner et al., 2014: p. 7).

Based on a closer examination of the translation of the Tempest stela, an alternative interpretation emerges that expands upon the theories put forth by Allen and Wiener. Noteworthy elements within the inscription reveal a narrative structure and significant details that deserve attention. The stela begins in the customary manner, with a listing of the numerous titles and names of Pharaoh Ahmose I. However, it is the subsequent storyline that captures interest. First and foremost, the scribe intentionally includes a reference to the offerings made by Ahmose I to the gods. This inclusion suggests a direct correlation between these acts of devotion and the subsequent events. The scribe perceives a link, indicating that Ahmose I's offerings had a direct impact on the unfolding narrative. Without this connection, the mention of the offerings would have seemed superfluous, thus underscoring their relevance within the composition.

The narrative progresses to depict a sudden and devastating storm that befalls Egypt, prompting Ahmose I to question the cause of the gods' anger. The construction of this particular line on the stela seems to imply that Ahmose I had initially expected a favorable outcome, only to be confronted with an unforeseen and fierce divine response. It becomes apparent that the pharaoh may have inadvertently elicited a more severe phenomenon than he had bargained for. While he may have anticipated moderate rainfall, the gods responded with a cataclysmic tempest, resulting in the destruction of a considerable portion of the state.

Following this calamity, Ahmose I undertakes the arduous task of rebuilding temples and pyramids. He also likely reassesses the Maat offering, the rituals, and the underlying processes to prevent such a catastrophic storm from recurring in the future. The subsequent period, encompassing Ahmose I's reign and that of a few pharaohs who succeeded him witnesses the presence of substantial yet moderate rainfall, as well as the occurrence of proper flooding.

4.3. Evidence 3—Ramesses III and Harris Papyrus

Ramesses III, during his reign, made significant contributions to the Nile gods. However, it is noteworthy that all these contributions were directed exclusively towards the Heliopolitan and Memphis regions, while the capital city of Thebes received none (Breasted, 1906: p. 96). Smaller temples in different areas also did not receive any donations. This consistent pattern persisted throughout Ramesses III's thirty two year reign as evidenced by the surviving Harris Papyrus, now held by the British Museum. One possible explanation for this selective allocation of offerings may lie in pragmatism. In order to present offerings to the Nile gods, Ramesses III would have required the necessary infrastructure, such as pyramids and granite coffers. It is important to note that Upper Egypt, including Thebes, lacked large-scale pyramids, with only smaller symbolic ones like the pyramid of Ahmose I present. Hence, it may have appeared illogical to

allocate resources to regions that did not possess the infrastructure required for grand offerings.

4.4. Evidence 4—Seventh's Dynasty Kings from Manetho's Account

The short reigns of the kings in the First Intermediate Period, particularly in the seventh dynasty, is an intriguing one. Manetho, an Egyptian priest from the third century BCE, allocated seventy days for seventy kings. Barbara Bell, in her research work, suggests that the short reigns may have been a result of the kings' inability to alleviate drought or bring about rainfall, which was then punished by sacrifice (Bell, 1971: p. 22). Although this scenario may seem uncommon, it is plausible in the context of dynastic Egypt, as the civilization occasionally resorted to extraordinary measures in times of trouble.

Expanding on Bell's line of reasoning, I suggest an alternative interpretation. Instead of the kings being sacrificed because they could not produce rain, they might have been sacrificed in an attempt to generate rainfall. It is noted that during the First Intermediate Period, Maat, the concept of right order and balance, was said to have been cast out or lost (James, 1960: p. 262). This implies that the rituals and processes related to offering to the Nile gods had been dismantled or forgotten, resulting in the loss of Maat. Manetho's account, if accurate, suggests that the dynastic Egyptians sought to restore Maat and revive the ancient practice of offering to the gods to regain their divine approval. One possible approach to reviving the lost knowledge, if indeed it was lost, could have been through trial and error. Each king might have been sacrificed, and a slightly different process employed each time to assess the outcome. However, it appears that this experimental approach did not yield the desired results, as the droughts and hardships of the First Intermediate Period persisted and somewhat beyond that until the 12th dynasty, specifically until the reign of Amenemhat I.

It is worth noting the irony that even the first sacrificed king may have been sufficient to bring about the desired outcome. Though, given the extremely short time span of one day, the likelihood of affecting rainfall would be unlikely. By examining Manetho's account and considering the absence of Maat during the first intermediate period, it is plausible to suggest that the sacrifices of the kings were an attempt to revive the ancient practice of offering to the gods and restore Maat. However, the effectiveness of these sacrificial rituals in alleviating drought and bringing rainfall appear to be futile.

4.5. Evidence 5—Amenhotep III's Sphinx Faience Statuette

The artifact held by the Metropolitan Museum of Art in New York, depicting Amenhotep III as a sphinx holding nu-jars, presents an interesting subject for analysis (**Figure 7**). Although limited information is available about this specific artifact, it is believed to be a smaller and likely copied version of a larger composition from the Amenhotep III's temple. The artifact is believed to be created around 1351 BCE.

Figure 7. Amenhotep III as a Sphinx, holding nu-jars. Metropolitan Museum of Art in New York.

One potential explanation for the composition is that it portrays Amenhotep III in the act of offering homage to the gods. However, sphinxes have a well-established historical connection with agriculture and safeguarding cultivated lands, from ancient times to the Roman era (Hassan, 1949: p. 128). Furthermore, sphinxes traditionally symbolized deities associated with death (Hassan, 1949: p. 148). Therefore, an alternative interpretation of this composition suggests that Amenhotep III is depicted as a revered "great god", already deceased. He is holding two jars in his hands filled with rainwater which he offers to Egypt to revitalize and rejuvenate the land. As previously discussed, a deceased king continues his caregiving role in a new capacity as a god. Consequently, this interpretation aligns with the themes of protecting cultivated lands and the association with a deceased ruler.

4.6. Evidence 6—Rain and Flood Anomalies

Karl Butzer, a leading geographer and archeologist observed a number of anomalies and irregularities for rain and Nile flood throughout the pharaonic Egypt which do not fit within a normal weather pattern (Butzer, 1958, 1984). Further Barbara Bell, adds more context in her analysis (Bell, 1971). I will cite a few excerpts from their work below, rearranged in a chronological order. A reader is encouraged to follow with the original works.

"*Throughout the southern Sahara the relatively moist conditions terminated in 2850 ± 100 BC… The Nile flood levels show a decline between the 1st and 2nd dynasties… which is a* thirty percent *reduction in discharge water… a seven year span of low Niles is alleged for the reign on Djoser culminating in Year 18, ca 2720 BC*".

Wet conditions were abruptly reestablished in East Africa ca. 1970 BC and the lake became 75 meters deeper which overflowed into the Nile System… the White Nile was 3 meters higher, with the discharge 10 times higher.

"*Sub-Saharian lake levels remained very low until 1950 ± 50 BC*"…

"*Multiple inscriptions dating to 1840-1770 BC, recoding floods 8 - 11 meters higher than at present… At least twice the basin water depth was present than at normal year… Comparable with catastrophic floods*".

"*Lake levels fell dramatically in East Africa ca. 1260 ± 50 BC. In Nubia, agriculture ceased almost entirely after the end of reign of Ramesses II* (*e.g., after 1212 BC*)… *where the floods were 1 m higher during Ramesses II's time, dunes spread over the floodplain… In the Delta, discharge* [*water*] *declined so much that the Ramessid residence of Avaris was abandoned… Famine during 1210 BC*"…

But in 1176 BC, Ramesses III made offering to the Nile gods to seek good floods… in 1153 BC [*shortly after the Ramesses III death*] *the food supply failed.*

The excerpts provided indicate that there was considerable variation in the Nile floods and rainfall during ancient Egypt, ranging from severe droughts to exceptionally high floods. These fluctuations may appear to be linked to the practices of the pharaohs. Some kings demonstrated a strong religious devotion and chose to follow Maat, the established customs and offering rituals of their predecessors. As a result, their reigns were often accompanied by regular rainfall and proper flooding.

Some others, perhaps for various reasons, decided to deviate from these traditional practices. This departure from tradition seemingly led to undesirable consequences. One speculative example is the period following the assassination of Ramesses III, who was known for his religious piety. It is suggested that his immediate successor, possibly the vizier, may have disregarded the importance of upholding Maat and ensuring the necessary offerings and rituals. Consequently, this abandonment of religious tradition may have contributed to a lack of rainfall, droughts, and subsequent hardships for the people as we know from the records.

4.7. Evidence 7—Blue Lotus

In his book "*Tutankhamen, Amenism, Atenism and Egyptian Monotheism,*" Sir Wallis Budge discusses a ritual practiced in ancient Egypt where prisoners of war were reportedly sacrificed to invoke the spirit of the sun at the apex of an obelisk (Budge, 1923: p. 62). According to this belief, the sun god resided within the obelisk stone, at the apex, known as a benben. It was thought that by performing this ritual the priests could invoke sun god who would emerge from the benben stone, rising from the blue lotus.

Budge explains that during this procedure, priests would offer beer, bread, sweets, and an ox placed likely in a sealed granite coffer, along with the sacrificed prisoner. It is suggested that the combination of pressure, yeast, and granite in this arrangement could create corona discharge light as previously explained. Consequently, observers may have witnessed a light phenomenon at the peak of the obelisk similar to the light illustrated in **Figure 8**.

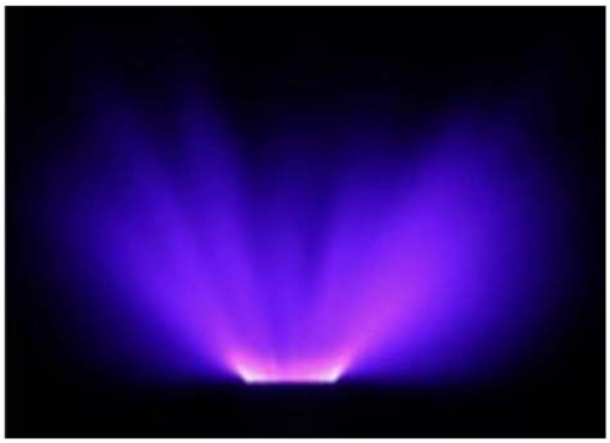

Figure 8. A light from corona discharge or ionization that appears when the electric field exceeds about 3000 Volts/mm in the air (Courtesy of Tao Shao, et al. 2011 "Runaway electrons and x-rays from a corona discharge in atmospheric pressure air" New Journal of Physics, Volume 13, Nov 2011).

The connection between this observed light and the concept of the blue lotus and sun god is speculative but understandable. It is likely that the ancient Egyptians, upon witnessing such light, may have associated it with the presence of sun god, rising from the blue lotus. The light is indeed reminiscent of the blue lotus.

4.8. Evidence 8—Joseph's Granaries and Hieroglyph O250

Following their visits to Egypt, the first European explorers brought back the notion that pyramids were used as granaries. However, it is clear that the pyramids were not constructed or equipped for grain storage. Nevertheless, an intriguing hieroglyph O250, which depicts a pyramid resting on a furrow sign, carries an agricultural association and seems to strengthen the connection between pyramids and granaries (Suignard, 2016: p. 185). These two instances, viewed independently, suggest the possibility of a grain-related function.

It is important to acknowledge that there may have been a misunderstanding of the term "granary" when European explorers introduced it. Rather than referring to a structure designed for grain storage, it could have been metaphorical, representing a structure that facilitated grain production. This aligns with the notion that pyramids were intended to enhance rainfall, promote precipitation, and improve overall vegetation growth. While this interpretation remains speculative, it complements the hypotheses previously outlined.

5. Conclusion

This study provides a thorough investigation of the well-documented Nile flood and rain anomalies, extensively discussed by esteemed experts Karl Butzer and Barbara Bell in their respective studies. The hypothesis introduced in this paper contributes novel insights into these anomalies by proposing that the intercon-

nected factors of Egyptian pyramids, religious practices, and Maat were significant drivers behind such anomalies. The notion of pyramids influencing rainfall, Nile flood and weather in general finds its foundation in the groundbreaking research of Charles Wilson, who elucidated the ability of electrically charged particles to stimulate precipitation. The distinct features of Egyptian pyramids further strengthen the hypothesis, indicating that ancient Egyptians could have possessed an understanding of such rainmaking process in dynastic times, employing a combination of granite coffers, rich in quartz, and fermentation in their practices. Moreover, the compelling use of well-established historical evidence presented in this study serves to fortify assertions made regarding the impact of the dynastic Egyptians on weather patterns.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Iron-Rich Red Clays on the Turin Shroud: Optical Microscopy Studies and SEM-EDX Analyses

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Abstract

We have explored by optical microscopy and scanning electrons microscopy coupled with energy dispersive X-ray fifteen particles located in a sample of the Face area of the Turin Shroud. They have the following peculiarities: they are alumino-silicate clays, with an elevated content (up to 56%) of iron; their sides are comprised between 1.5 µm and 19 µm; their forms are rounded or more elongated, but more often with angular outlines. When observable, their colours are red or red-brown. All these particles have a little quantity of the phosphorous element (up to 5%) in their compositions. The biggest ones show some morphological heterogeneity on their surfaces, suggesting that they are chipboards of some micro-organisms.

Keywords

Turin Shroud, Face Area, Red Clays, Optical Microscopy, Scanning Electron Microscopy, Energy Dispersive X-Ray

1. Introduction

The Turin Shroud (TS), the most important Christ's relic, is a well known object in which a body image is imprinted. Numerous scientific approaches were realized concerning this precious relic (Marion & Lucotte, 2006). We have obtained a small triangular sticky tape that was sample d on its surface (corresponding to the Face of this body) and we concentrated in the past years on the study of microscopic organic structures located on the surface of this sticky tape, including: linen fibers (Lucotte, 2015a), pollens and spores (Lucotte, 2015b), red blood cells (Lucotte, 2015c), skin debris (Lucotte, 2016), an hair fragment (Lucotte &

Thomasset, 2017a) and osseous remains (Lucotte & Thomasset, 2017b). More recently, we published gold and silver particles (Lucotte, 2022a), and lapis lazuli particles (Lucotte & Thomasset, 2023), detected on the surface of the triangle.

In a preliminary analysis (Lucotte, 2012), we studied some particles, notably the b8 and the ei4 particles, that seems to look like (by their morphologies and sizes) to red blood cells; they are in fact some peculiar clays (Lucotte, 2022b), with elevated values of iron oxide in their compositions, that conferring to it the red colour observed in optical microscopy.

In the present study, for obtaining precisions about these peculiar red clays, we observe and characterize in details the clay particles (including b8 and i4) located on the surface of the triangle, presenting such similar peculiarities. A total number of fifteen particles were so detected.

2. Material and Methods

The material is a small (1.36 mm height, 614 µm wide) sticky tape triangle at the surface of which all particles were deposited. For practical reasons, the surface of this triangle was subdivided in 19 (named A to S) sub-samples areas (Lucotte, 2017). The positions of each particle sticking to the triangle surface were located in a double system of coordinates (in 186 adjacent squares of 50 × 50 µm). Particles of the sample were observed, with any preparation, on the adherent part of the triangle surface. All the particles described here were studied by optical microscopy and by SEM (Scanning Electron Microscopy)-EDX (Energy Dispersive X-ray) analysis.

Most of the particles studied were first observed by optical microscopy using a photo-microscope Zeiss, model III, 1972. The corresponding photographs were named as direct when they correspond to those studied by SEM-EDX, and as inverse hen it is the other side of the triangle that was observed.

Two SEM apparatus (SEM1 and SEM2) were used; both are Environmental versions: 1/A Philips XL. 30 instrument. GSE (Gaseous Secondary Electrons) and BSE (Back Scattered Electrons) procedures were used, the last one permitting the detection of heavy elements. 2/A FEI model Quanta 25 of FEG, both in LFD (Large Field Detector) and CBS (Circular Back Scattering) procedures.

Elemental analysis for each particle were realized by EDX, the SEM1 apparatus being equipped with a Bruker probe AXS-EDX and the SEM2 apparatus with a probe model X-flash 6/30. Each elemental analysis is given in the form of a spectrum, with kiloelectrons/Volts (ke/V) on the abscissa and elemental peak heights in ordinates. Highly resolutive (HR) spectra are those where the ordinate scale is in logarithms, for a better distinction of little peaks.

Normal compositions in elements are those where carbon and oxygen are not taken in consideration.

3. Results

The enlarged (about 1200×) optical view of **Figure 1** shows the right part of the B area of the triangle. Three red particles are visible in this view: the b8 particle

and the b 24 and b25 (red-brown) particles. Adjacent particles b24 and b25 are located to the left part of b22, which is a golden particle (Lucotte, 2015a).

The SEM1 photograph of **Figure 2** shows the b8 particle. It is a rounded particle of a maximal diameter of about 12 μm. Because of its form and colour, it mimics red blood cells (Lucotte, 2015c). There are three deposits at the b8 surface: a triangular Diatom, and two micro-filaments of titanium (Ti). The b8 surface is not smooth, and shows some evidence of micro-heterogeneity.

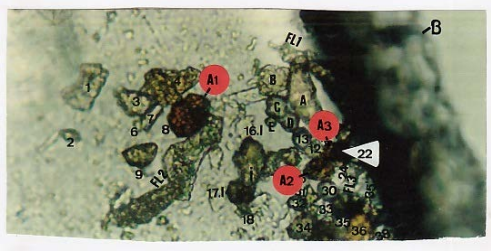

Figure 1. Optical view (1200×) of some part of the B area, showing the three particles A1 (b8), A2 (b25) and A3 (b24); b22 is a particle of gold alloy. B: the right border of the B area.

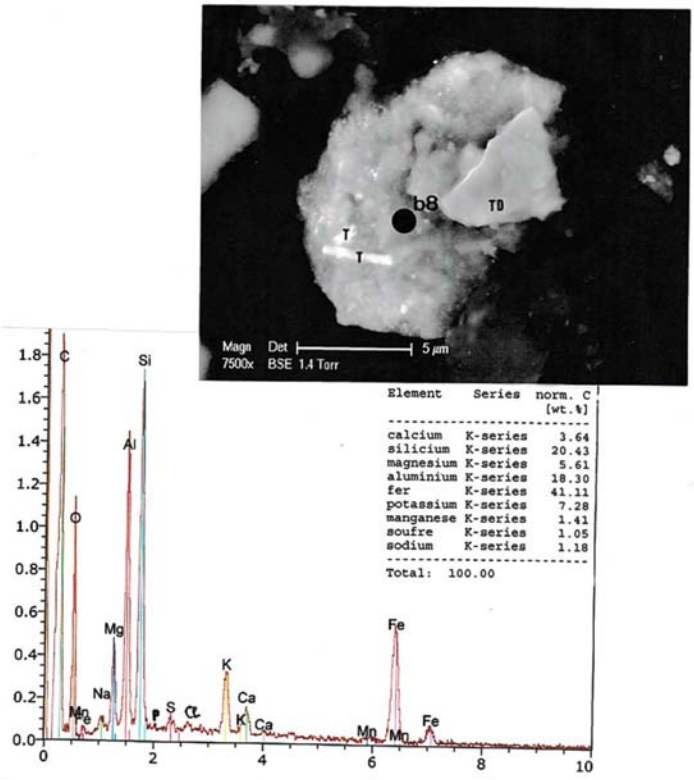

Figure 2. The b8 particle. *Above*: SEM1 photograph (7500×), in BSE, of the b8 particle. T: two titanium micro-filaments; TD: a Triangular Diatom. The big dot in the b8 center indicates the approximate area of the particle where EDX analysis is realized. *Below*: the b8 spectrum. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P (traces): phosphorous. S: sulphur; Cl chlorine; K (two peaks): potassium; Ca (two peaks): calcium; Mn (traces): manganese. *Insert*: the normal composition (in wt. %) in elements of b8 (fer: iron; soufre: sulphur).

The b8 spectrum shows that it is a typical clay: the silicium (Si), the aluminium (Al) and the magnesium (Mg) peaks are in order of decreasing heights; there is potassium (K) and calcium (Ca). It is an iron-rich clay, because the iron (Fe) value is of about 41% and there are traces of manganese (Mn), attesting the "mineral" nature of the iron. There are little peaks of sodium (Na), of sulphur (S) and of chlorine (Cl) and also some traces of phosphorous (P).

The SEM1 photograph of Figure 3 shows the b24 particle, which is with hexagonal outlines and has a maximal measurement of about 6 µm. It is a clay, with an important main peak of iron; it has phosphorous and sulphur traces. This particle is contaminated by the gold (Au) of the b22 particle.

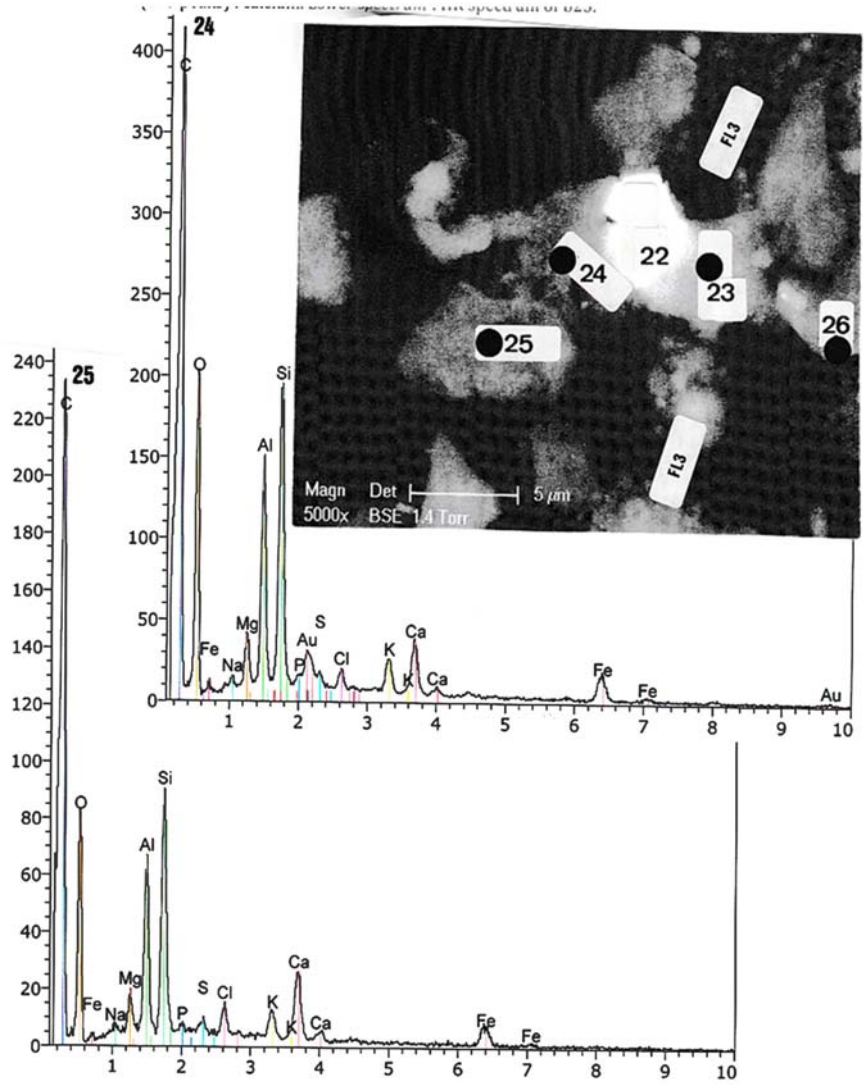

Figure 3. *Above*: SEM1 photograph (5000×), in BSE, showing particles b25, b24, b22, b23 and b26. FL3 are two parts of the linen fiber 3. *Upper spectrum*: HR spectrum of the b24 particle. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P (traces): phosphorous; Au (two peaks): gold; S: sulphur; Cl: chlorine; K (two peaks): potassium; Ca (two peaks): calcium. *Lower spectrum*: HR spectrum of b25.

Similarly the b25 particle is also with hexagonal outlines, with a maximal measurement of 6.5 µm. It is also a clay, with an important mean peak of iron and little phosphorous and sulphur peaks.

Because of the proximity of b23 and b26 particles with the right border of the B area, we cannot see their colours in optical microscopy. They are two particles with hexagonal outlines, and with maximal sizes of 6 µm and 5.5 µm, respectively.

The b23 spectrum (Figure 4) is that of a clay with an elevated mean peak of iron, and phosphorous and sulphur traces. This particle is contaminated by the gold of b22. The b26 spectrum is also that of a clay with an elevated main peak of iron, and little peaks of phosphorous and sulphur.

Because of the proximity of a25 and a27 particles with the right border of the A area (Figure 5), we cannot see their colours. The a25 particle is with pentagonal outlines and of 6.5 µm of size; its spectrum is that of a clay with an important mean peak of iron, and with phosphorous and sulphur traces. The a27 particle is a little (3 µm) rounded particle; its spectrum is also that of an illite, with an important mean peak of iron and with phosphorous and sulphur little peaks (it is contaminated by titanium).

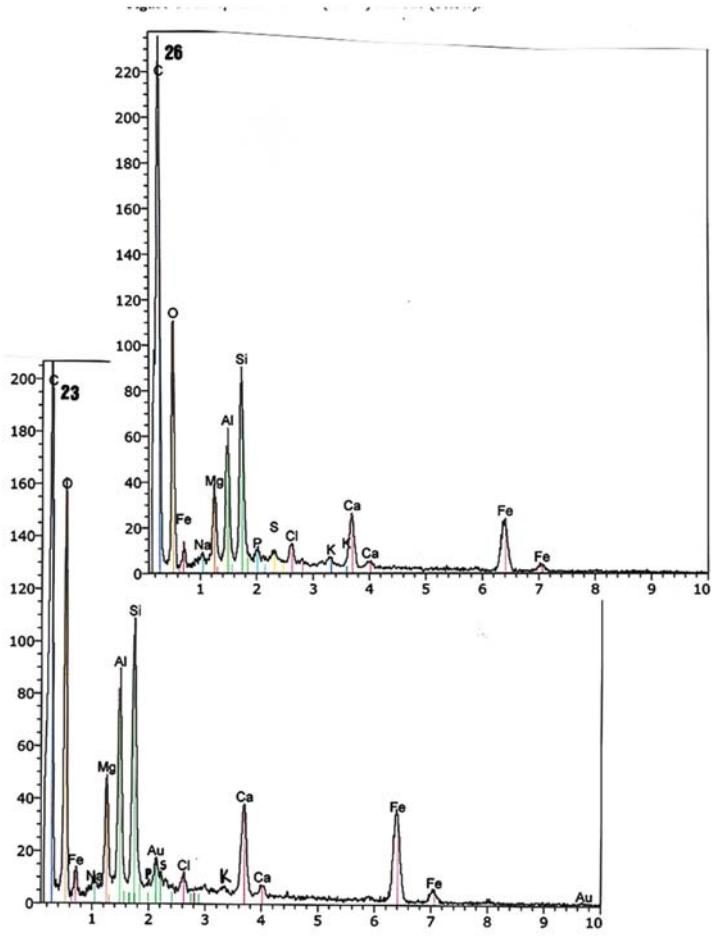

Figure 4. HR spectrum of b26 (above) and b23 (below).

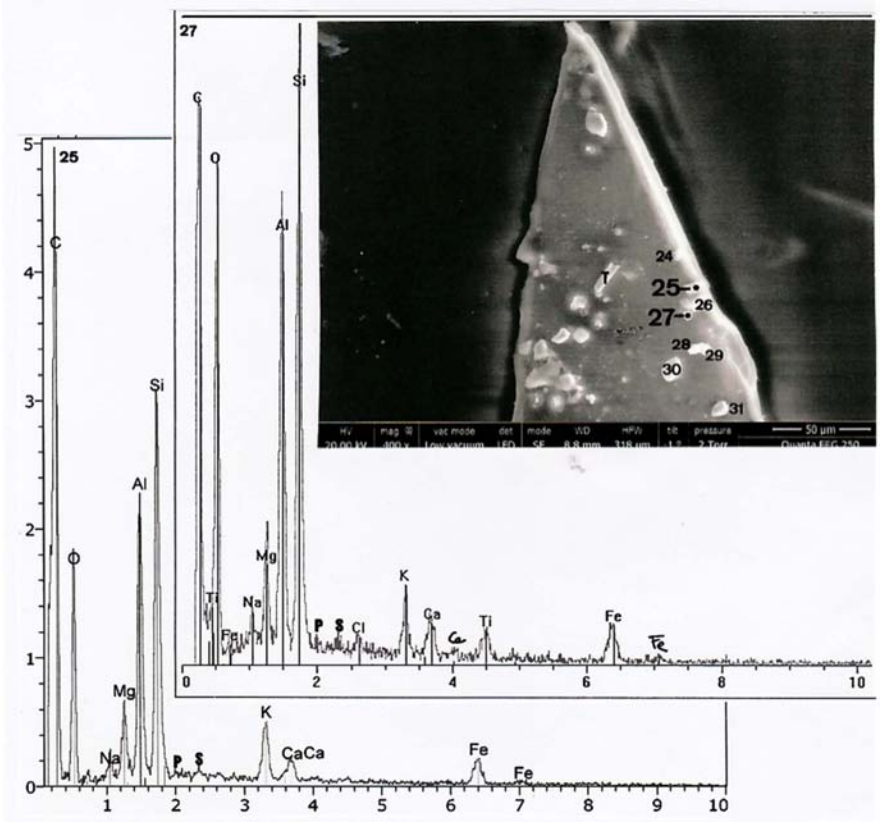

Figure 5. The a25 and a27 particles. *Above*: SEM2 photograph (400×), in LFD, the upper part of the A area, showing particles a25 and a27. (T is a titanium micro-filament). *Upper spectrum*: HD spectrum of a27. C: carbon; Ti (two peaks): titanium; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium. P: phosphorous; S: sulphur; Cl: chlorine; K: potassium; Ca (two peaks): calcium; *Lower spectrum*: HD spectrum of a25.

The optical photograph of Figure 6 of the lower part of the A area shows that the a41 particle is of a red-brown colour. It is a pentagonal particle of 5.5 μm of size; its spectrum is that of a clay with an elevated mean peak of iron. It has an important peak of phosphorous and a little peak of sulphur.

The SEM2 photograph of Figure 7 shows, in the right part of the G area, the g27, g30 and g33 particles; g27 is in fact (see the SEM photograph of Figure 8) a complex particle, constituted of at least seven parts (**1** - **7**). Its maximal length is of about 18 μm. The g30 particle is of small size (about 3.5 μm) and with a triangular form, but careful examination (see Figure 8) shows that it is driven under part 6 of g 27, and so must be of greater size. The g33 particle is squared in form, with a maximal size of 10.5 μm. These three particles are covered by very fine deposits of calcium carbonate micro-grains.

The inverted optical view of Figure 7 shows that the g27, g30 and g33 particles are of red-brown colours.

Figure 8 shows the g27 spectrum, that is of a clay with an elevated mean peak of iron; it has little peaks of phosphorous and sulphur. This spectrum shows an elevated value of the main calcium peak.

Figure 6. The a41 particle. *Above photograph*: optical view (1200×) of the left part of the low A area, showing the a41 particle (arrow point). P1 is a triangular fold of PVC plastic in this area part (B is the right border of the A area). *Below photograph*: SEM1 photograph (4000×) in GSE, showing the emerging part of the a41 particle (a42 is a glass and a43 a trilobed calcium carbonate). *Below*: the HR a41 spectrum. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; S: sulphur; K: potassium; Ca (two peaks): calcium.

Figure 9 shows the spectra of the g30 and g33 particles. Both are those of a clay with important main peaks of iron. The two spectra have peaks of phosphorous and sulphur, and elevated values of the main calcium peaks.

The inverted optical view of **Figure 10** shows, in the right part of the I area, the red-brown colour of the i4 particle. The SEM1 photograph of **Figure 10** shows that it is an elongated particle, with at least 9.5 µm of size. Careful examination of its surface permits to see that it is entirely constituted of some forms of micro-organisms of characteristic patterns.

The i4 spectrum is that of a clay, with an important peak of iron; it has little peaks of phosphorous and sulphur. It shows an elevated value of the main calcium peak, and traces of copper (Cu).

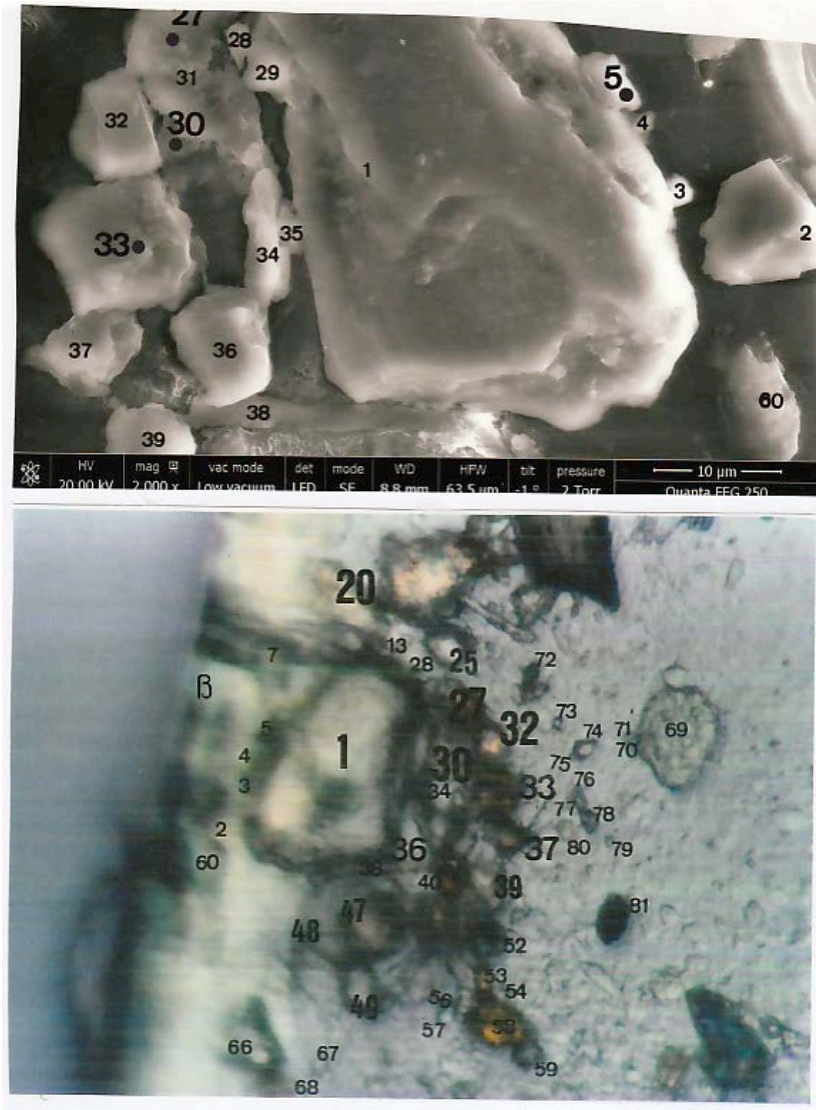

Figure 7. The g27, g30 and g33 particles. *Above*: SEM 2 photograph (2000×), in LFD, of some part of the G area (showing the different particles that surround the great g1 particle, which is a peridot), where particles g27, g30 and g33 are indicated in capital numbers (g28 is a glass; g29 is a calcium carbonate; g31 indicates fine deposits on g27 and g30; g32 is a dolomite; g34 is a biotite; g35 is a calcite; g36 is a silica; g37 is a phosphorite; g38 is the basal part of a silk fiber; g39 is a silica). *Below*: inverted optical view (1200×) of some part of the G area showing particles located at the left part of the g1 particle (a peridot), g27, g30 and g33 particles are indicated in capital numbers. (B Is the right border of the G area).

The SEM1 photograph of **Figure 11**, of a left part of the J area, shows the j50 and j51 particles. The j50 particle, detached from j51, is a little (1.5 µm) squared particle. Its spectrum is that of a clay, with an iron content of about 60%. It has a little peak of phosphorous. The j51 particle is elongated, with 7.5 µm of maximal length. There is also some evidence of micro-organisms on its surface. Its spectrum is that of a clay, with an elevated value of the main peak of iron; it has a little peak of phosphorous.

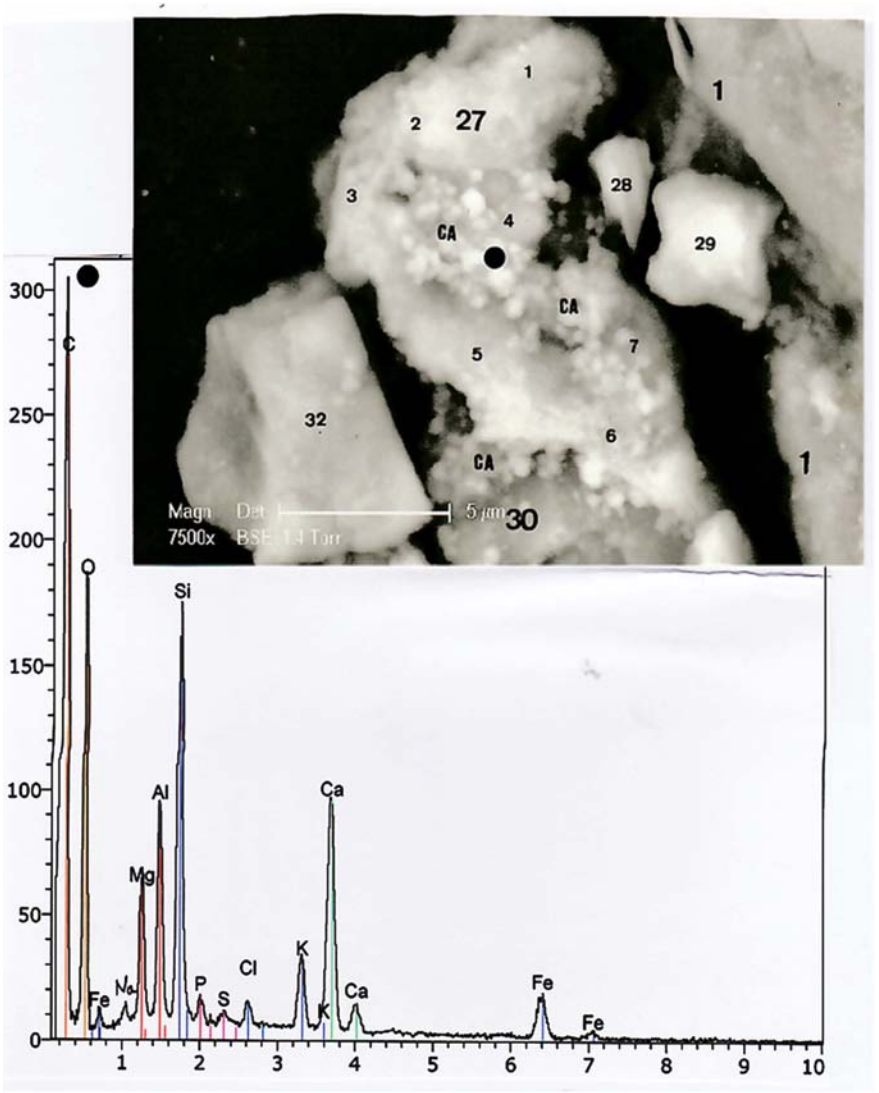

Figure 8. The g27 particle. *Above*: SEM1 photograph (7500×), in BSE, showing the g27 particle (covered, as the g30 particle, by a fine deposit of calcium carbonate: Ca). This complex is compounded of at least seven parts (numbered 1 to 7); the black point indicates the g27 region where EDX analysis is realized. *Below*: the HR spectrum of g27. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; S: sulphur; Cl: chlorine; K (two peaks): potassium; Ca (two peaks, with a major one): calcium.

Because of the proximity of j50 and j51 particles with left border of the J area, it is difficult to see their colours. Careful examinations of some optical views of the region shows however one yellow-red spot corresponding to the j50 particle, and a pale-red spot corresponding to the j51 particle.

The inverted optical photograph of Figure 12 shows, in the central part of the L area, the red colour of the l11 particle. The SEM photograph of that figure shows that l11 is an elongated complex particle, of a maximal length of 9 µm, constituted of at least three parts (**1**, **2** and **3**). There is also evidence of micro-organisms on its surface.

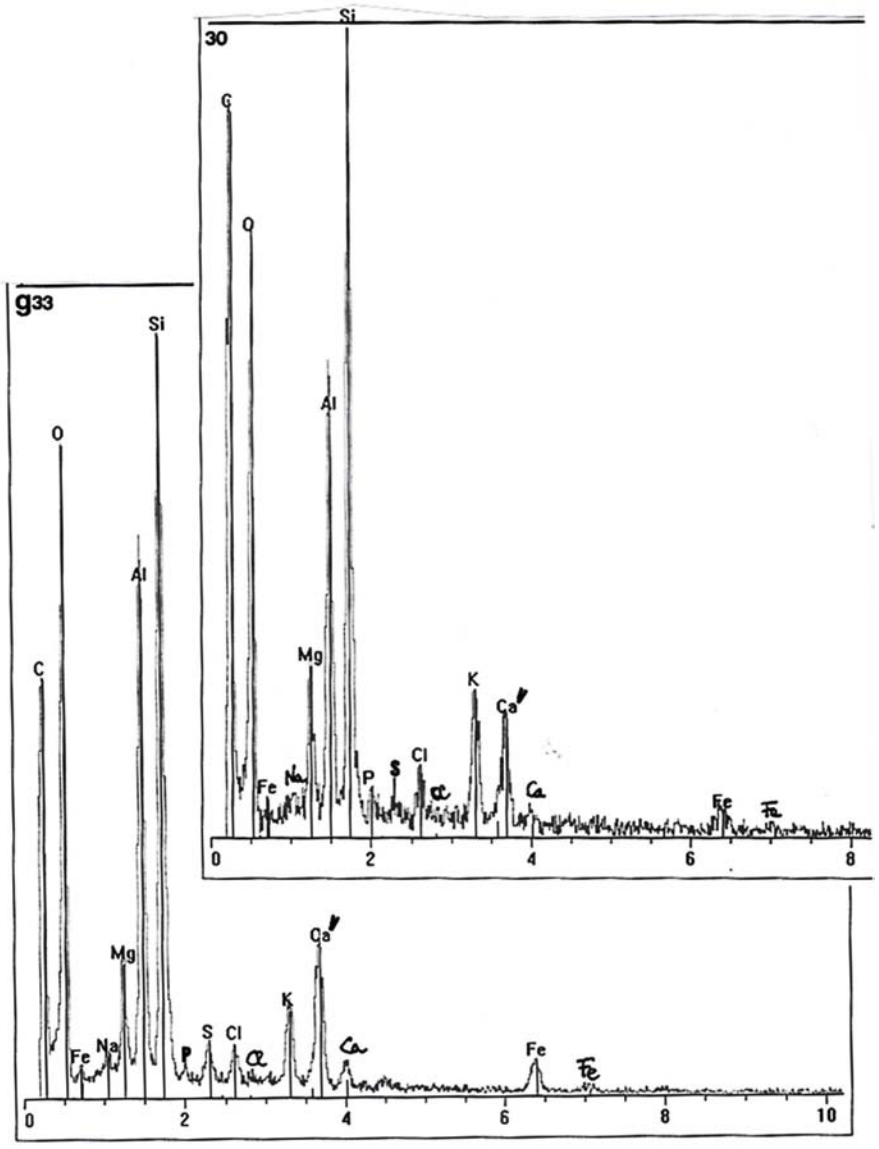

Figure 9. HR spectrum of the g30 (above) and g33 (below) particles. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; S: sulphur; Cl (two peaks): chlorine; K: potassium; Ca (two peaks): calcium (the arrow points indicate calcium carbonate contamination).

The l11 spectrum is that of a clay, with an iron value of about 56%. It has a great peak of phosphorous (of value of about 5%) and a smaller peak of sulphur (of a value of about 2%); the value of chlorine (about 6%) is also relatively elevated.

4. Discussion

Table 1 lists and characterizes the fifteen (three in the A area: a25, a27 and a41; five in the B area: b8, b23, b23 and b24, b25 and b26; three in the G area: g27, g30 and g33; one in the I area: i4; two in the J area: j50 and j51; one in the L area: l11) iron-rich clay particles detected in the various areas of the triangle. All have

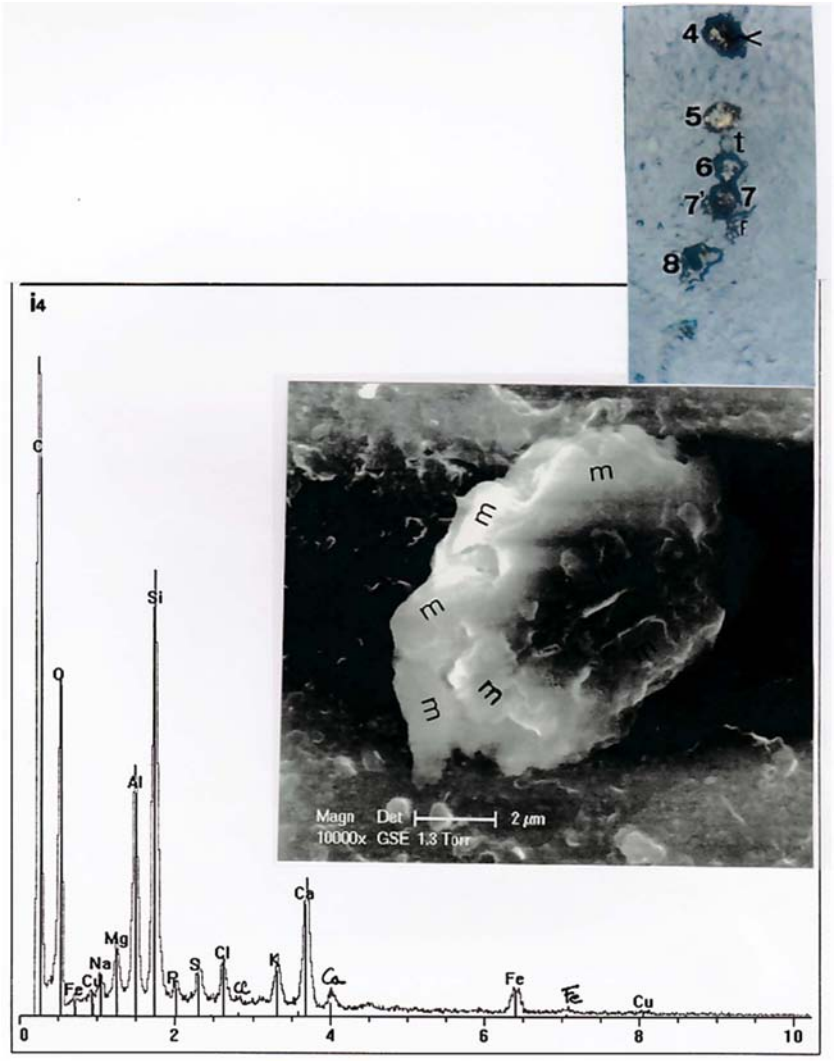

Figure 10. The i4 particle. *Upper photograph*: inverted optical view (1200×) of the right part of the I area showing the i4 particle (arrow point). *Lower photograph*: SEM1 photograph (10,000×), in GSE, of the i4 particle (m: micro-organisms). *Below*: the i4 spectrum. C: carbon; O: oxygen; Fe (three peaks): iron; Cu (two peaks): copper; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; S: sulphur; Cl (two peaks): chlorine; K: potassium.

spectra of typical clays, with elevated iron-values; the iron oxide conferring a red colour, all these (when observable in optical microscopy) particles are of red-brown or red colour. So these iron-rich clays participate, together with those of hematite, biotite and cinnabar already detected (Lucotte et al., 2016), to the observed reddish tint of the triangle (Lucotte, 2017).

These iron-rich clays are of some interest for understanding the origin of the TS, because the soil of Mt. Sion (in Jerusalem) contains some red illites with quasi-similar spectra (Fanti et al., 2015). However more accurate analyses are necessary for a complete identification of these minerals, which are very similar to the clays of other Mediterranean areas influences by the winds of the Sahara desert.

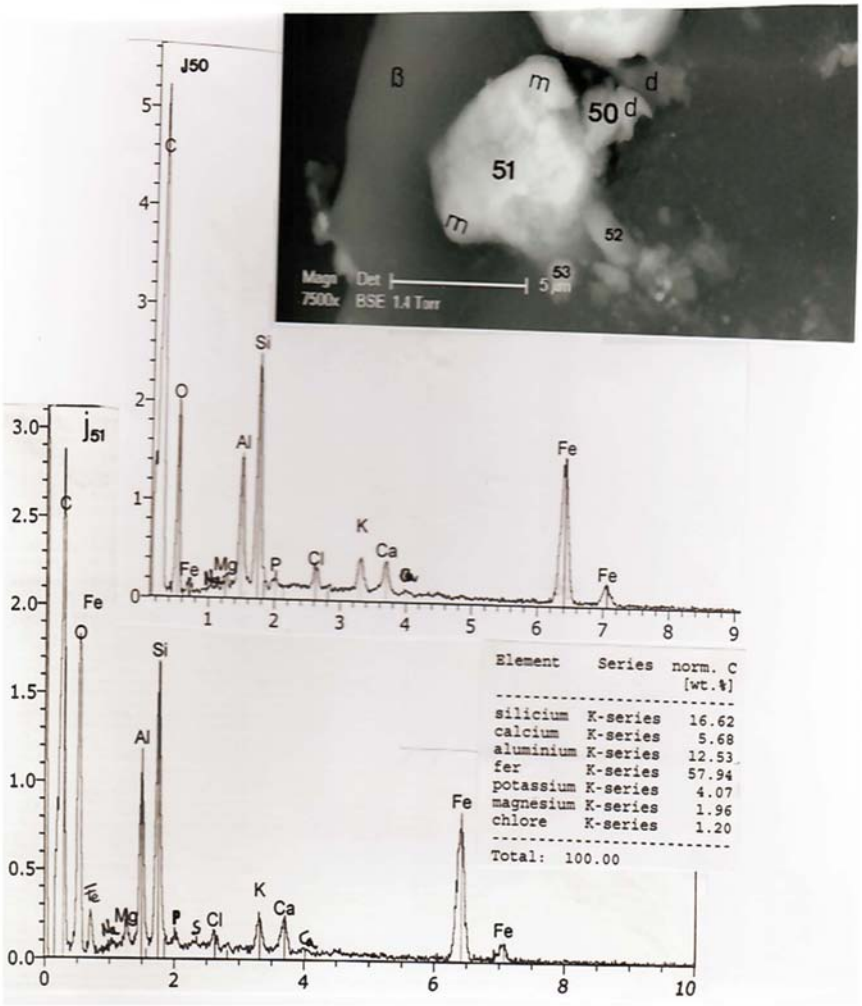

Figure 11. The j50 and j51 particles. *Above*: SEM1 photograph (7500×), in BSE, of some part of the left J area showing particles j50, and j51 with micro-organisms (m) on its surface; j48 is a spore, j49 a complex calcium carbonate, j52 a kaolinite iron-rich and j53 another clay iron-rich; B is the left border of the J area. *Upper spectrum*: the j50 spectrum. C: carbon; O: oxygen; Fe (three peaks): iron; Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; Cl: chlorine; K: potassium; Ca (two peaks): calcium. *Lower spectrum*: the HR j51 spectrum. Insert: the normal composition; (in wt.%) in elements of j50 (fer: iron; chlore: chlorine).

The forms of these particles can be rounded (a27 and b8) or more elongated (i4, j51 and l11), but most often with angular outlines. The most elementary form is that of pentagonal or hexagonal particles (a25, a27, a41, b23, b24 and b25). Two particles (g33 and j50) are squared, and one (g30) is triangular.

Table 2 summarizes the multipartism of particles, and their phosphorous and sulphur contents. There is heterogeneity in the surface of the b8 particle. Particle g27 is in seven parts. Visible micro-organisms are observed on the surfaces of the i4, j51 and l11 particles. The i4 surface (Figure 10) appears as quasi-entirely make-up of these micro-organisms, and similar patterns are observed for j51 and l11.

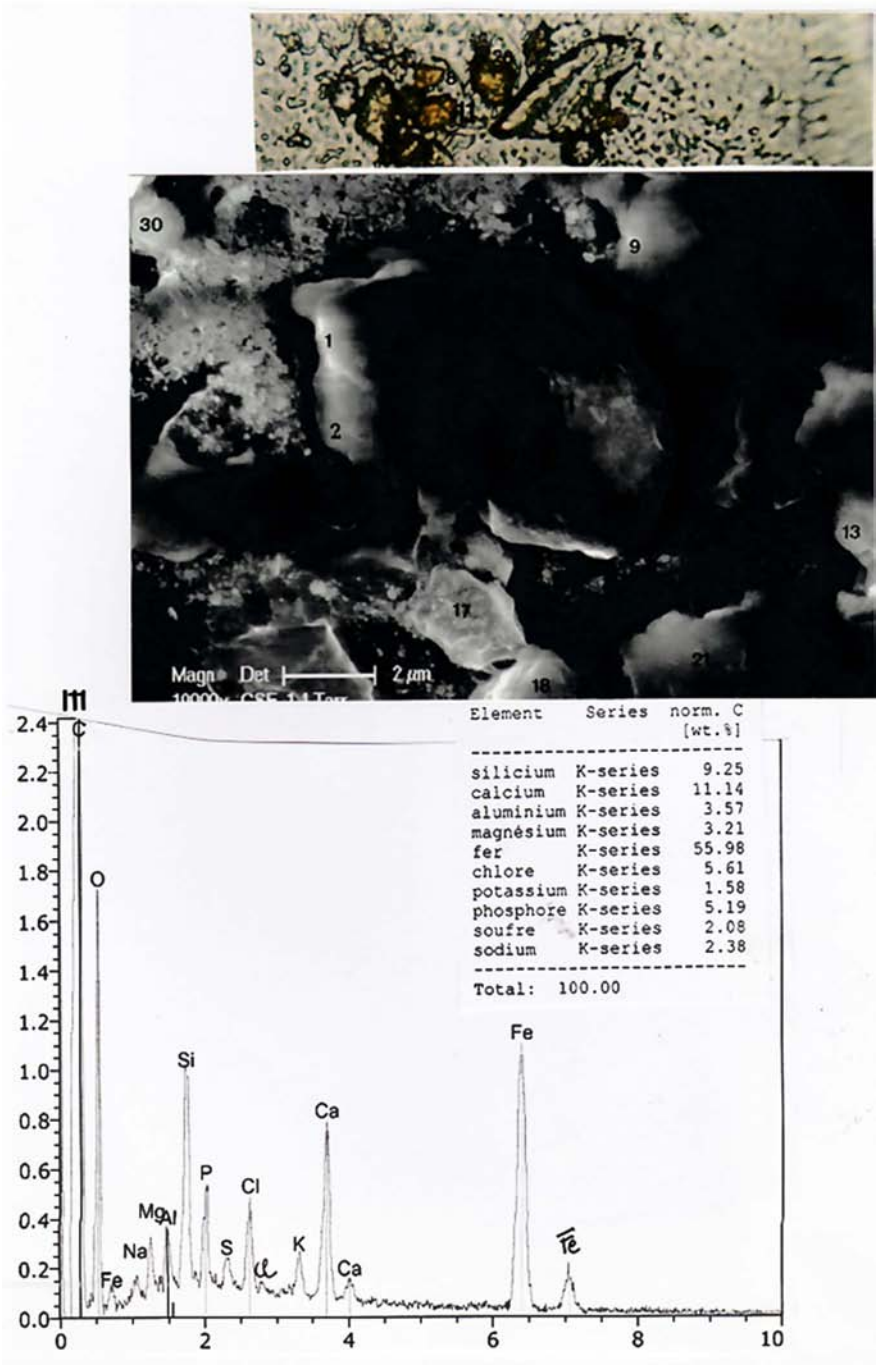

Figure 12. The l11 particle. *Upper photograph*: optical view (1200×) of some part of the L area showing the l11 particle; other red particles are l8 (an hematite particle) and l26 (a phosphorite iron particle). *Lower photograph*: SEM1 photograph (10,000×) in GSE, of some part of the L area showing the l11 particle, constituted of three parts (1, 2 and 3), and micro-organisms (m) on its surface (l16 is a Diatom, l17 a lapis-lazuli, l18 a possible citrine; l21 and l15 are PVC plastics, l13 and l30 are calcites and l25 is a gypsum). *Below*: the HR l11 spectrum. C: carbon; O: oxygen; Fe (three peaks): iron, Na: sodium; Mg: magnesium; Al: aluminium; Si: silicium; P: phosphorous; S: sulphur; Cl (two peaks): chlorine; K: potassium; Ca (two peaks): calcium. *Insert*: the normal composition (in wt. %) in elements of l11 (fer: iron; chlore: chlorine; phosphore: phosphorous; soufre: suphur).

Table 1. List and characterizations of the iron-rich clay particles detected on the various areas of the triangle.

Particle numbers	Areas of the triangle	Particles	Forms	Maximal dimensions (in µm)	Spectra of clay	Iron values	Colours	Peculiarities
1	A	a25	pentagonal	6.5 µm	+	three peaks	?	
2	A	a27	rounded	3 µm	+	three peaks	?	contaminated by titanium
3	A	a41	pentagonal	5.5 µm	+	elevated value of the main peak	red-brown	
4	B	b8	rounded	12 µm	+	41%	red	
5	B	b23	hexagonal	6 µm	+	elevated value of the main peak	?	contaminated by the Au of b22
6	B	b24	hexagonal	6 µm		three peaks	red-brown	
7	B	b25	hexagonal	6.5 µm	+	three peaks	red-brown	
8	B	b26	hexagonal	5.5 µm	+	elevated value of the main peak	?	
9	G	g27	elongated	19 µm	+	elevated value of the main peak	red-brown	contaminated by Ca
10	G	g30	triangular	3.5 µm	+	three peaks	red-brown	contaminated by Ca
11	G	g33	squared	10.5 µm	+	three peaks	red-brown	contaminated by Ca
12	I	i4	elongated	9.5 µm	+	three peaks	yellow-red point	
13	J	j50	squared	1.5 µm	+	58%	red-pale point	detached from j51
14	J	j51	elongated	7.5 µm	+	elevated value of the main peak		
15	L	l11	elongated	9 µm	+	56%	red	massively contaminated by Cl

Table 2. Multipartism of the iron-rich clays and their contents in phosphorous and sulphur.

Particle numbers	Particles	One or several parts	Phosphorous	Sulphur
1	a25	one part	traces	little peak
2	a27	one part	little peak	little peak
3	a41	one part	elevated peak	little peak
4	b8	heterogeneity	traces	1%
5	b23	one part	traces	little peak
6	b24	one part	traces	little peak
7	b25	one part	little peak	little peak
8	b26	one part	little peak	little peak
9	g27	seven parts	little peak	little peak

Continued

10	g30	one part	little peak	little peak
11	g33	one part	little peak	little peak
12	i4	visible micro-organisms inside	little peak	little peak
13	J50	one part	little peak	no
14	J51	visible micro-organisms inside	little peak	little peak
15	L11	invisible micro-organisms inside	5%	2%

All the particle spectra (but j50) have sulphur little peaks, reaching 1% in b8 and 2% in l11. All these particles have phosphorous in their spectra, most often in the form of traces (a25, b8, b23 and b24) or little peaks of this element (a27, b25, b26, g27, g30, g33, i4, j50 and j51), reaching 5% in l11.

5. Conclusion

We detected fifteen clay particles (a25, a27, a41; b8, b23, b24, b25, b26; g27, g30, g33; i4; j50, j51 and l11) on the various parts of the triangle surface. They have the following characteristics: they are particles of maximal sizes comprised between 1.5 μm (for j50) and 19 μm (for g27). Their forms are rounded or more elongated, but more often with angular outlines.

They are alumina-silicate clays, with an elevated content (up to 56% of the normal composition for particle l11) of iron; when observable, their colours are red or red-brown. Interest of these particles concerns their potential relationships to blood.

All these particles have a little quantity of the phosphorous element in their compositions (up to 5% for the particle l11). The biggest ones show some heterogeneity at their surfaces; visible micro-organisms, constitutive of these clays, are observed on the surfaces of particles i4, j51 and l11.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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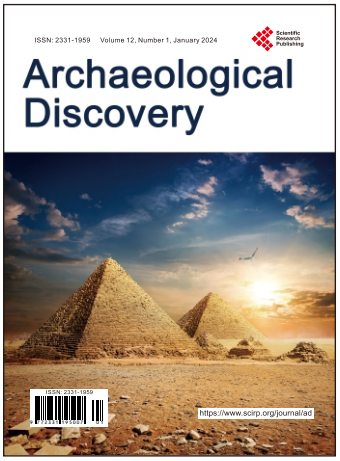

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