International Journal of Archaeology
2017; 5(1): 6-13
http://www.sciencepublishinggroup.com/j/ija
doi: 10.11648/j.ija.20170501.12
ISSN: 2330-7587 (Print); ISSN: 2330-7595 (Online)

The Agricultural Environment's Effect on the Deterioration of the Archaeological Sites Applied on Atfiyah's Sarabium Archaeological Site – Egypt

Rabea Radi Abdel Kader, Shaimaa Sayed Mohamed El-Sayed*

Restoration Department, Faculty of Archaeology, Cairo University, Cairo, Egypt

Email address:
Egyptianconservators2013@gmail.com (S. S. M. El-Sayed)
*Corresponding author

To cite this article:
Rabea Radi Abdel Kader, Shaimaa Sayed Mohamed El-Sayed. The Agricultural Environment's Effect on the Deterioration of the Archaeological Sites Applied on Atfiyah's Sarabium Archaeological Site – Egypt. *International Journal of Archaeology*. Vol. 5, No. 1, 2017, pp. 6-13. doi: 10.11648/j.ija.20170501.12

Received: July 10, 2016; **Accepted**: October 17, 2016; **Published**: April 15, 2017

Abstract: The Agricultural Environment has a severe effect on the deterioration of the archaeological sites, it causes many deterioration phenomena to these sites, most of them are biodeterioration and the others are physio – chemical deterioration**.** Sarabium archaeological site located in Atfiyah's center – Egypt, it belonged to 26th dynasty, the site suffers from the agricultural environment's effect because it is very near from the fields in the area (100 meter approx. far only). The most effective factor of deterioration is the groundwater which affects badly on the deterioration of the building materials there, many microorganisms grow on lime stone carved coffins and ruins, they secret organic compounds which react with lime stone and turn it to soluble salts, the groundwater comes from the fields and contains many salts which dissolve in it and rise with the capillary system to the building materials not only this effect, but also the intensive growth of weeds in the site. This research aims to study the agricultural environment's effect on the deterioration of the archaeological sites with an application on Atfiyah's Sarabium archaeological site – Giza -Egypt.

Keywords: Sarabium Archaeological Site, Ground Water, Microorganisms, Limestone, Weeds and Salts

1. Introduction

Sarabium archaeological site located in Atfiyah's center – Giza governorate, Apis bull buried in many tombs which Called "Sarabium" like Saqqara Sarabium site but Atfiyah's Sarabium is for the burial of Hathur cow which was the main goddess of Atfiyah's center in this time, the site contains many tombs for Hathur cow from the 26th dynasty [1].It suffers from the existence of groundwater in the carved limestone's coffins because of the short distance between the site and the fields around it, it is lower than the surrounded area and the groundwater aggregates inside the coffins.

2. Materials and Methods

2.1. The Ground Water's Analysis

We took water's sample from one of the limestone's coffins to identify it, the sample analyzed in Water testing central laboratories – Drinking Water and Sanitation Company in Fayoum governorate. Figure (1-3).

2.2. The Analysis of Limestone Ruins

A sample of limestone was analyzed by X- Ray Diffraction (XRD) to identify its components and examined by Scanning Electron Microscope (SEM) to study the surface; also the sample was analyzed by EDAX (Energy dispersive x-ray spectroscopy). Figure (4-6).

2.3. Identification of the Limestone's Ruins Mortar

A sample of mortar was analyzed by X- Ray Diffraction (XRD) to identify its components, examined by Scanning Electron Microscope (SEM) to study the surface, and examined by Polarizing microscope to identify its components. Figure (7-9).

2.4. The Analysis of the Mud Bricks Ruins

A sample of mud bricks was analyzed by X- Ray Diffraction (XRD) to identify its components and examined by Scanning Electron Microscope (SEM) to study the surface; also the sample was analyzed by EDAX (Energy dispersive x-ray spectroscopy). Figure (10-12).

2.5. Identification of the Microbiological Effect of the Groundwater

From the water's analysis, we are identifying the microbiological effect of groundwater on the limestone' Coffins and ruins. Figure (13).

No.	Inorganic Parameter	Unit	Criteria for treated water	Criteria for raw water	% Uncertainty	LOQ	LOD	Ground water sample
	Sample Code							S/W02/09/13/200
1	Temperature	C°		> 5				NA
2	Res.Chlorine	ppm	5					NA
3	pH		6.5-8.5	7-8.5	0.85	0.108	0.032	7.89
4	Total dissolved solids	ppm	1000					1609
5	Nitrate (NO_3)	ppm	45	> 45	4.4	0.126	0.011	AC
6	Total alkalinity	ppm		20-150	1.8	7.338	4.427	99.2
7	Total hardness	ppm	500		3.24	3.706	1.112	802.4
8	Permanent hardness	ppm						703.2
9	Temporary hardness	ppm						99.2
10	Calcium hardness	ppm	350					729.6
11	Magnesium hardness	ppm	150					72.8
12	Chlorides	ppm	250		4.1	0.486	0.166	142.19
13	Fluoride	ppm	0.8	< 0.5		0.011	0.004	1.117
14	Sulfate	ppm	250	< 200	12.9	0.091	0.031	1000.09
15	Color	Pt/Co	< 5	< 100				NA
16	CO_3	ppm						NA
17	HCO_3	ppm		20-150	1.8	0.597	1.989	NA
18	Po_4	ppm						NA
19	Total phosphours	ppm						NA
20	Ammonia (NH_3)	ppm	0.5	> 0.5				NA

AC : The parameter accredited test NA: Not analyzed ND: Not detected

Figure 1. *Shows the inorganic parameters of the ground water sample.*

Environmental Conditions : Temperature :22.5:23.2c
Relative Humidity :34:37%

RESULTS (Accredit test)

No.	Inorganic Parameter	Unit	Criteria for treated water	Criteria for raw water	% Uncertainty	LOQ	LOD	Ground water sample
	Sample Code							S/W02/09/13/200
1	Turbidity	NTU	1		6.3	0.212	0.125	3
2	Electric cond.	µS/cm			2.142	0.580	0.174	2680
3	Nitrite (NO_2)	ppm	0.2		13.7	0.004	0.001	0.04
4	Nitrate (NO_3)	ppm	45	> 45	4.4	0.126	0.011	18.28
5	Aluminum (Al)	ppm	0.2		2.2	0.060	0.018	ND
6	Calcium (Ca)	ppm			4.2	0.53	0.160	161.4
7	Cadmium (Cd)	ppb	30	< 10	5.2	0.516	0.155	ND
8	Chromium (Cr)	ppb	50	< 50	3.8	1.913	0.574	ND
9	Iron (Fe)	ppm	0.3	< 1	3.5	0.079	0.024	ND
10	Lead (pb)	ppb	10	< 50	5.0	5.542	1.663	ND
11	Magnesium (Mg)	ppm			0.9	0.038	0.011	16.7
12	Manganese (Mn)	ppb	400	< 500	3.4	1.317	0.395	7.73
13	Zinc (Zn)	ppb	3000	< 1000	5.0	31.166	9.35	53.4
14	Total alkalinity	ppm		20-150	1.8	7.338	4.427	99.2
15	Total hardness	ppm	500		3.24	3.706	1.112	802.4
16	Ammonia (NH_3)	ppm	0.5	< 0.5				NA

N AC:Not accredit NA: Not analyzed ND: Not detected NR: Not repor

Figure 2. *Also shows the inorganic parameters of the groundwater sample.*

No.	Inorganic - Metal Parameter	Unit	Criteria for treated water	Criteria for raw water	% Uncertainty	LOQ	LOD	Ground water sample
	Sample Code							S/W02/09/13/200
1	Arsenic (As)	ppb	10	50		5.0	1.66	NR
2	Barium (Ba)	ppb	700			1.0	0.33	24.3
3	Beryllium (Be)	ppb				1.0	0.33	ND
4	Cobalt (Co)	ppb				1.0	0.33	ND
5	Copper (Cu)	ppb	2000	< 1000		5.0	1.66	15.99
6	Potassium (K)	ppm				0.5	0.166	NA
7	Lithium (Li)	ppb				1.0	0.33	NA
8	Sodium (Na)	ppm	200			0.5	0.166	272.5
9	Nickel (Ni)	ppb	20			1.0	0.33	4.37
10	Phosphorus (P)	ppb				1.0	3.33	NA
11	Silicon (Si)	ppm				0.4	0.12	22.9
12	Strontium (Sr)	ppm				0.2	0.06	5.073
13	Titanium (Ti)	ppb				1.0	0.33	2.231
14	Vanadium (V)	ppb				1.0	0.33	43.20

NA: Not analyzed ND: Not detected NR: Not reported

Figure 3. *Shows the metal parameters of the groundwater sample.*

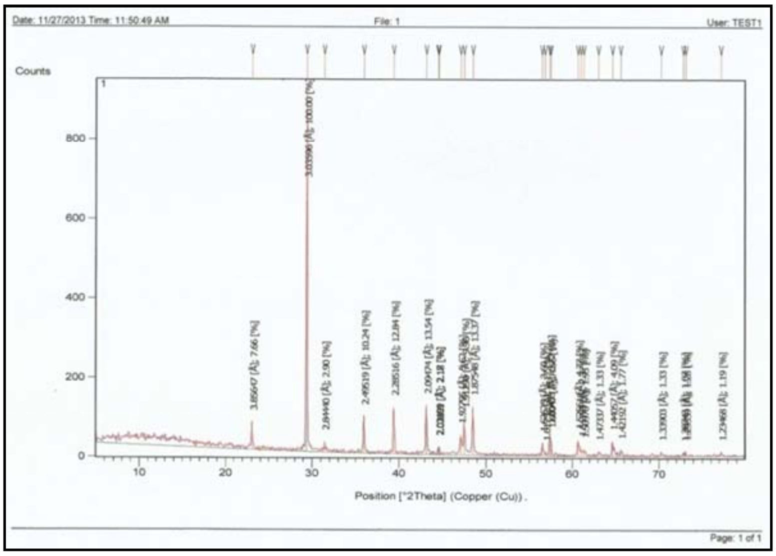

Figure 4. *Shows the XRD's pattern of the limestone's sample.*

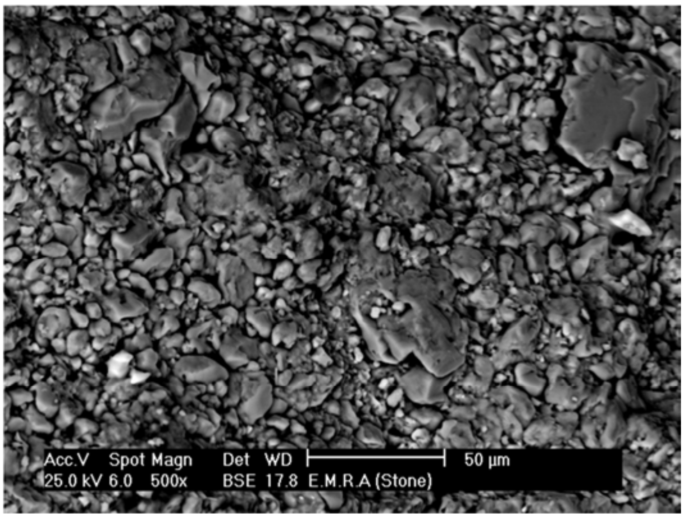

Figure 5. *The SEM's examination of the limestone's sample surface.*

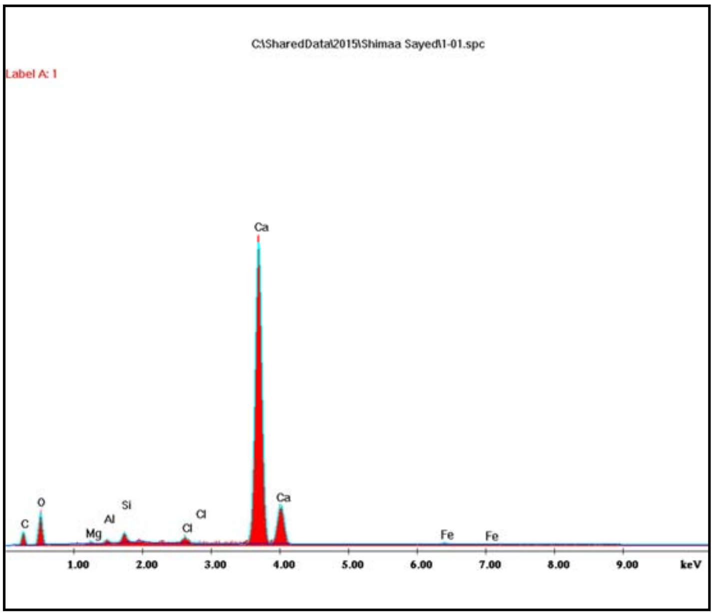

Figure 6. *Shows the EDAX's analysis of the limestone's sample.*

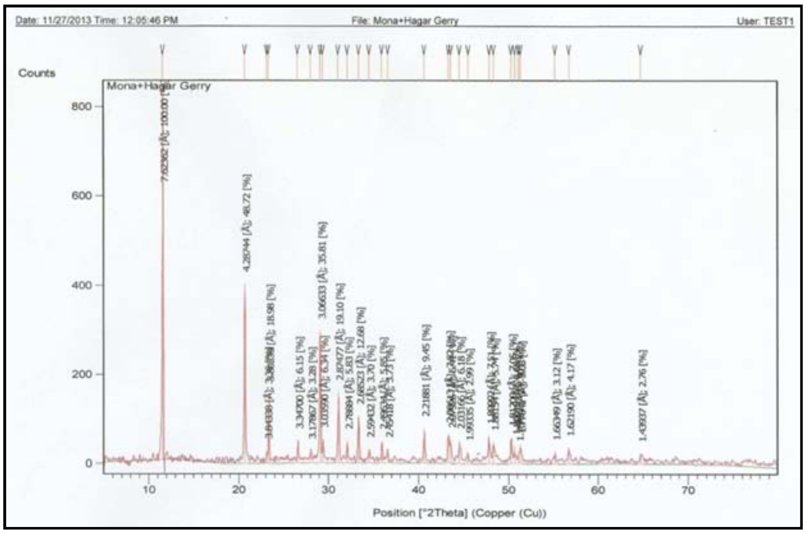

Figure 7. *Shows the XRD's pattern analysis of a mortar's sample from the limestone' ruins.*

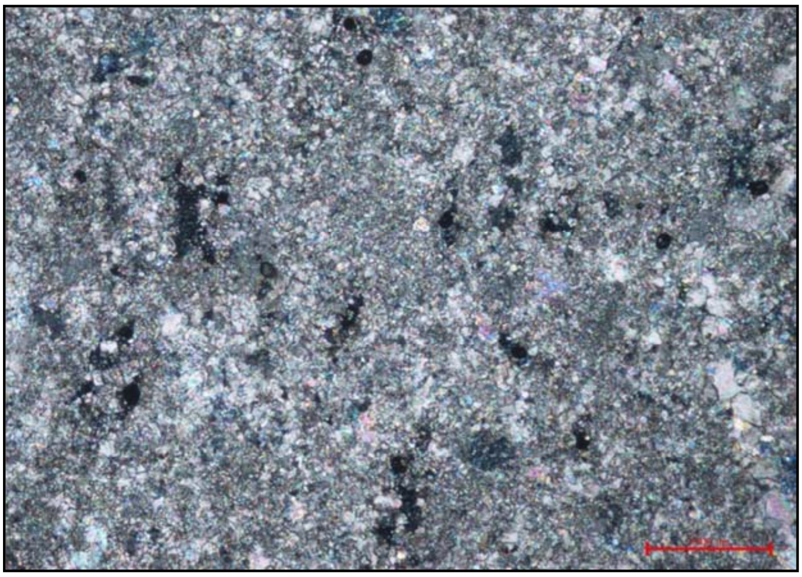

Figure 8. *Shows the polarizing microscope's examination of a mortar's sample from the limestone' ruins.*

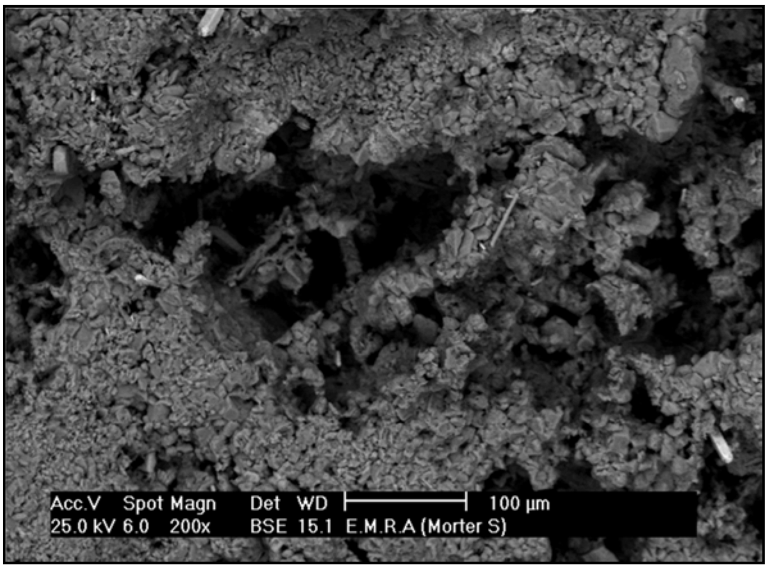

Figure 9. *Shows the SEM's examination of a mortar's sample from the limestone' ruins.*

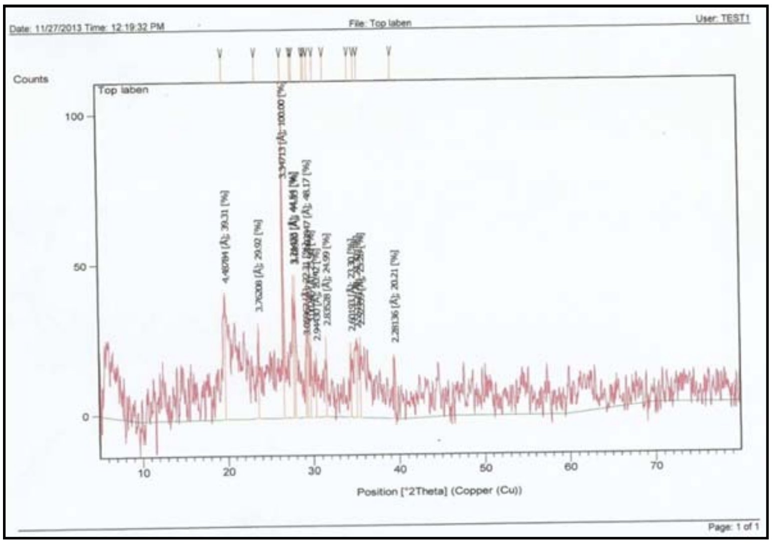

Figure 10. *Shows the XRD's pattern analysis of the mud brick's sample.*

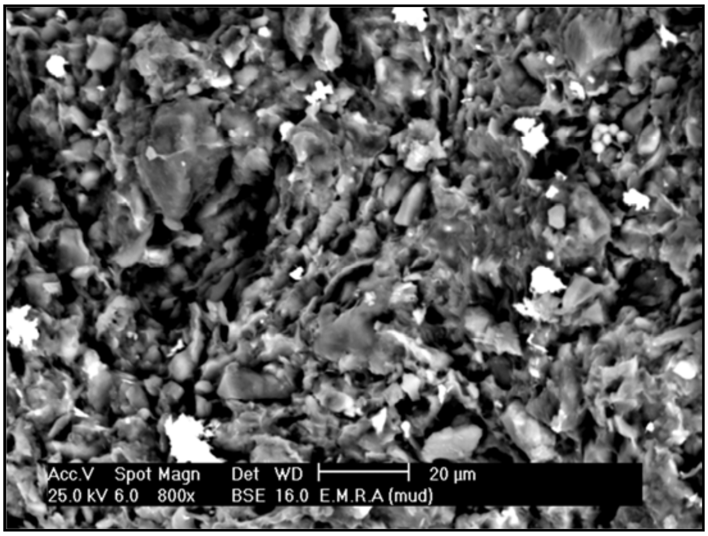

Figure 11. *Shows SEM's examination of the mud brick's sample (X 800).*

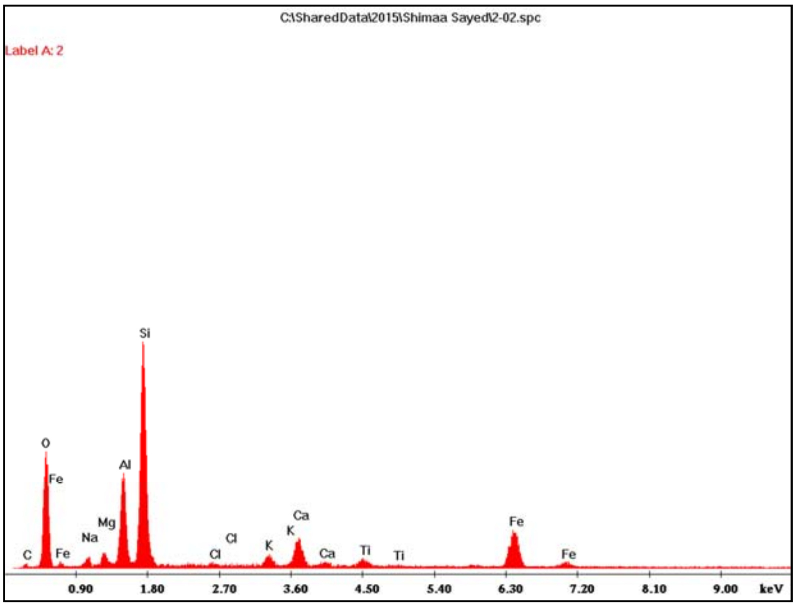

Figure 12. *Shows the EDAX's analysis of the mud brick's sample.*

No.	Bacteriology and Biology Parameter	Unit	Criteria for treated water	Criteria for raw water	% Uncertainty	LOQ	LOD	Ground water sample
ample Code								S/W03/09/13/200
A	*Bacteriology*							
1	Fecal coliform	CFU/100ml	0		12.06			NA
2	F.streptococcus 48h	CFU/100ml			14.5			NA
B	*Biology*							
1	*Microscopic*							
a	Algae	Organism						NA
b	Amoeba							NA
c	Other Protozoa							NA
d	Helminthes							NA
2	*Algae Count*							
a	Blue Green	Organism/ml						254
b	Green	Organism/ml						NA
c	Diatom	Organism/ml						28212
d	Total	Organism/ml						28466

Figure 13. *Shows the Microbiological analysis of the groundwater's sample.*

2.6. Identification of Grown Weeds in the Site

A sample of plants or weeds which grew intensively in the site was taken and identified with the plants laboratory in the Agricultural and Biological Research Division – National Research Center – Egypt. Figure (14-16).

Figure 14. *Shows an overview of Sarabium's archaeological site, fields are very near to the site.*

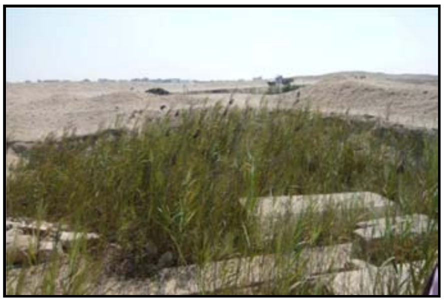

Figure 15. *Shows the wide growth of weeds in limestone' coffins area in Sarabium archaeological site.*

Figure 16. *Shows the growth of weeds in mud bricks' ruins area in Sarabium archaeological site.*

3. Results and Discussion

(1) The groundwater's type in Atfiyah's Sarabium Archaeological site is Agriculture waste water due to the existence of sulphates and chlorides with high percentages, also the existence of coliform bacteria which live in the wet soils with high contamination, site is very near to the fields (100 meter far approx.) and the site is lower than the surrounding area, the agriculture waste water aggregates in the most lower point in the archaeological site (limestone' coffins).

(2) The limestone's sample contains calcite (Calcium carbonates) (the main component with 70%), hydrous calcium sulphates (8%), quartz (Silicon dioxide 9%) and sodium chloride 13%), and the examination with scanning electron microscope shows the weakness of the surface.

(3) The source of the high percentage of salts in the limestone's sample (Sodium chloride 13% and hydrous calcium sulphates 8%) is the agriculture waste water in the site which rises in the stone with the capillary system.

(4) The EDAX sample's analysis shows the existence of the followed elements (Ca, O, Cl, Na, S and Si) which confirms the XRD's sample analysis results.

(5) The analysis of the limestone ruins' mortar with XRD shows that it is a gypsum mortar and its components are gypsum (Hydrous calcium sulphates) (39.78%), calcite (Calcium carbonates) (29.23%), quartz (5%), hematite (Ferrous oxide) (10.4%), halite (Sodium chloride) (15.59%), the existence of halite salt with high percentage due to the ground water existence in the site and rising of it in the wall by the capillary system.

(6) The polarizing microscope's examination of the mortar shows the existence of gypsum, calcite, quartz, halite in the sample which confirms the XRD's analysis result of the same sample.

(7) The Scanning Electron Microscope (SEM) examination of the mortar's sample shows the weakness of the mortar and the high existence of salts (Halite) inside it in the needle's form.

(8) The analysis of mud bricks' sample with XRD shows that the main component is Quartz (45.9%), Calcite (22.12%), Albite (20.45%) and Halite (11.48).%

(9) The examination of the mud bricks ' sample with SEM

shows that mud bricks are very weak in the site because of the high percentage of quartz in them and the wide growth of weeds which penetrate deeply in mud bricks walls ruins and destroy them.

(10) The elemental analysis of mud bricks' sample with EDAX confirms the XRD's analysis.

(11) The identification of the Microbiological effect of the groundwater shows the existence of blue green algae (Cyanobacteria) and diatoms (Bacillariophyceae) in the water, the transmission and growth of these microorganisms in the limestone's coffins and ruins' surface), the blue green algae and diatoms grow in the existence of sunlight to make photosynthesis.

(12) The organic activity of the algae consist biofilm which deforms the limestone's view by their stains, also the algae fix the carbon and provide a source of nutrition for heterotrophic microorganisms which may further degrade the stone 's surface (bio weathering of the stones) [2], Figure (17-22).

(13) The existence of the agriculture waste water in the site causes the high growth of some weeds like *Phragmites communis* (Trin.) and *Sonchus oleraceus* (L.) [3].

Figure 17. *Shows the blue green algae under the microscope.*

Figure 18. *Shows the diatoms under the microscope.*

Figure 19. *Shows the agriculture waste water aggregates in one of the limestone' coffins in the site.*

Figure 20. *Shows growth of salts and algae inside the limestone's coffin.*

Figure 21. *Shows the growth of algae on one of the limestone' ruins surface in the study area and staining of it.*

Figure 22. *Shows the growth of algae on the external surface of one of the limestone' coffins.*

4. Conclusion

The Agricultural environment has a bad effect on the archaeological sites especially Sarabium's archaeological site in Atfiyah – Giza- Egypt, the effects are the groundwater's existence (Agricultural waste water), the growth of salts in the building materials or on their surface, the wide growth of weeds, the growth of microorganisms on the building materials (Algae).

Acknowledgment

To Central Laboratories of Water Analysis – Fayoum Drinking Water and Sanitation Company (FDWSC) – Ministry of Housing and Utility – Egypt especially Chemist / Marwa Sayed Mahgoub.

- Prof. Dr / Mohamed Abdel Hady Mohamed - Prof. of Restoration and Conservation - Faculty of Archaeology – Cairo University - Egypt.

- Prof. Dr / Hussein Fawzy Hussein AbouZainah - Prof. of Botany – Agricultural and Biological Research Division- National Research Centre – Egypt.

- Mr / Sabry Gaber- Pests and weeds management laboratory – Antiquities ' Researches and Conservation center – Project Sector – Ministry of Antiquities – Egypt.

References

[1] Mission égypto-française d'Atfih, 'Atfih, la nécropole des vaches sacrées (mission 2008), Institut d' Egyptologie Francois Daumas, Universite Paul Valery, France, 2008.

[2] Nick A. Cutler, Heather A. Viles, Samin Ahmad, Stephen McCabe, Bernard J. Smith, Algal 'greening' and the conservation of stone heritage structures, Science of the Total Environment 442, (2013), P: 153.

[3] Shaimaa Sayed Mohamed El-Sayed Mahgoub, ' Evaluation of Wild and Domestic Trees and Plants Hazards, their Role in the Deterioration of Archaeological Buildings Ruins, Methods of Treatment and Assessment of these Hazards Applied on a Chosen Historical Building and Site ', PhD thesis, Restoration department, Faculty of Archaeology, Cairo University, Egypt, 2015/2016.