Physico-Chemical Analyses of Pottery From the archaeological sites of the West Bank of the Nile in Shendi Region (Almatamma to Gouz Burra)

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Abstract

The study aimed at identifying the components of pottery specimens as well as determining their firing index. The specimens were selected, as random samples, from the sites of the West Bank of the Nile in Shendi region from Almatamma to Gouz Burra and subjected to Physico-chemical analyses (X-ray Diffraction, Thermal and X-ray fluorescence analyses). The experimental method has been employed in addition to the historical, descriptive, and analytical one. The results showed that the components of the pottery specimens are similar, except one, which indicate a local derivation of the clays used in the manufacture of the pottery in the region. The firing index (firing temperature, firing time and atmosphere of firing) of the pottery samples in question suggests the use of similar firing techniques. As for the thermal analysis, with its indicators (the degree of burning, its duration and environment), it indicates a relatively high burning temperature (above 450 degrees Celsius), which shows the ability of the potters at the time to produce pottery with good burning despite the primitive methods used. The similar burning methods of the owners of these archaeological sites across different historical periods may suggest that they may come from one cultural area.

Keywords: Pottery, West Shendi, XRD, DTA/TG, XRFS, Archaeology.

مستخلص

هدفت الدراسة لمعرفة مكونات القطع الفخارية وأوجه الشبه والاختلاف بينها ومغزى ذلك. وتم إختيار عينات عشوائية من مواقع الضفة الغربية للنيل باقليم شندي ،(المنطقة من المتمة إلى قوز برة)، وأخضعت لتحاليل فيزيائية وكيميائية(الأشعة السينية ،التحليل الحراري والتحليل الإشعاعي الطيفي). وقد إتبع

المنهج التجريبي بالاضافة للمنهج التاريخي الوصفي التحليلي.و توصلت الدراسة إلى تشابه في مكونات القطع الفخارية ماعدا قطعة واحدة مما يرجح الإحتمال باستخدام طينة محلية لصناعة الفخار بالمنطقة.أما التحليل الحراري بمؤشراته (درجة الحرق وفترته وبيئته) فيومئ إلى درجات حرق عالية نسبيا (أعلى من ٤٥٠ درجة مئوية) توضح مقدرة الفخاريين آنذاك على إنتاج فخاريات جيدة الحرق رغم بدائية الأساليب المتبعة.وربما توحي أساليب الحرق المتشابهة لأصحاب هذه المواقع الأثرية عبر أحقاب تاريخية متباينة إلى أنهم ربما يتحدرون من منطقة ثقافية واحدة.

كلمات مفتاحية : فخار،غرب شندي،الأشعة السينية، التحليل الحراري. التحليل الإشعاعي الطيفي، آثار،

Introduction:

West Shendi archaeological Project affiliates to Shendi University, covering the area on the western bank of the Nile, from Almatamma to Gouz Burra. The project comes as a direct legal birth of the Qatari full support in its second stage, season 2014—2015, and proportional support in the second & third seasons of 2016—2017 and 2017—2018 and fourth season 2018-2019.

The concession of the mission is in Almatamma and the villages of its north The area that was surveyed in the three seasons includes the following villages: Gouz Burra, Gouz Badur, Al Jabalab, Taybat Al Khawad, Almagaweer, Assufur, Annourab, Ajewer, Al Kimair, Arrahamab, Al Karada, Al Abdutab, Al Hamerab, Galee Wad Eisa, Al Oqda, Assayal Al kabeer (SayalkareemAdeen), AssayalAssageer and Almatamma .

The aforesaid, clearly reflects the few archaeological researches in the area. What the project, achieved in this short period, can be considered as a beginning for a systematic archaeological research in the region. The project uncovers significant sites, relics and the features of the area (Nada, 2018.p2).

The present article is devoted to broad physic-chemical analyses of the pottery types derived from the surveyed sites on the west bank of the Nile in Shendi region (from Al matamma to Gouz Burra) (see supra) spanning a long period of time.The aim is twofold: To determine the

lithological provenance of the pottery and ascertain the nature of the cultural interactions (if any) that existed between the various human groups inhabited this region since ancient times.

Previous Studies:

The few archaeological studies on the western bank of the Nile were conducted by Hintza, (Hintza, 1958.pp171-1996), Ahmed Khidir Abdul Abdelkarim (Ahmed, 1984) Edwards, D. N.(Edwards, D. N,2004) and Crowfoot. J. W. (Crowfoot. J.w, 1911). Also Lenoble. P., in March 1987, in AlHobagi south of Almatamma (70 kilometers upper the royal cemeteries in ancient Mreowe), ran little excavations. (Lenoble.P.2004, pp115-141).Besides, the survey of the area from Matamma to Begrossi – North of Matamma- that was conducted by the director of West Shendi Archaeological Project (Nada Babiker) in her doctorate degree. Add to these, the studies ran by the graduate and undergraduate students.

Methodology:

The researcher used an interdisciplinary approach (the historical, descriptive and analytical method in addition to the experimental method) in the analyses of the selected pottery from the surveyed sites. The experimental methods (X-ray diffraction, thermal and X-ray fluorescence analyses) were used here in order to identify the clay source of the pottery in question and using it to decipher the cultural relationship between the various sites in the Shendi region from Almatamma to Gouz Burra.

Samples of the study:

Random samples were collected from the archaeological sites recorded by West Shendi expedition according to chronological and technical sequence.

Table(1): Pottery samples selected from the sites of the West Bank of the Nile in Shendi region the area from(Almetmma to Gouz Burra)

No	Coordinates		Manufacturing type (by wheel or by hand)	Location	Period
	E	N			
1	0567361	1871835	By hand	West Gouz Badur Cemeteries(1)	Meroe
2	0565091	1872886	By hand	West Gouz Badur Cemeteries(4)	Meroe
3	0565621	1870887	By wheel	West Gouz Badur Cemeteries (5)	Meroe
4	0565309	1870366	By wheel	West Gouz BadurCemeteries (6)	Meroe

No	Coordinates		Manufacturing type (by wheel or by hand)	Location	Period
	E	N			
5	0565860	1870291	3 samples by hand One sample by wheel	West Gouz BadurCemeteries(7)	Meroe
6	0565445	1869947	2 samples by hand. One sample by wheel	West Gouz Badur Cemeteries (8)	Meroe
7	0565011	1869429	One sample by hand. One sample by wheel.	West Gouz Badur Cemeteries (9)	Prehistory Meroe
8	0570830	1870786	2 samples by hand.	Alfikhikhira(1)	Meroe
9	0567285	1872482	By hand	West Gouz Burra Cemeteries (3)	Islamic
10	0567377	1881847	By hand	North Gouz Burra Cemeteries (6)	Meroe
11	0560153	1885655	By hand	North Gouz Burra Cemeteries (17)	Meroe
12	0570105	1870487	By wheel	Um Gragrat	Meroe
13	0559882	1861663	One sample by hand. One sample by wheel.	West Al Magaweer Cemeteries (3)	Meroe
14	0557421	1859203	By hand	West Assufur) Cemeteries (2)	Meroe
15	0556636	1858620	By hand	West Assufur) Cemeteries (3)	Meroe
16	0567232	1870027	By wheel	Al Shabaka	Meroe
17	0546778	1851924	By hand	GouzJakak	Prehistory
18	0534775	1850505	By hand	North Matamma Cemeteries (11)	Meroe

No	Coordinates		Manufacturing type (by wheel or by hand)	Location	Period
	E	N			
19	0567264	1871870	By hand	Um Gamai	Prehistory
20	0564510	1868016	2 samples by hand	West wadiAlharan cemeteries(1)	Meroe
21	0542296	1850633	2 samples by hand	North SayalSageer cemeteries(1)	Prehistory
22	0540040	1851026	By hand	North SayalSageer cemeteries(4)	Prehistory
23	0539500	1847577	By hand	Al FakiBabiker	Prehistory
24	0539223	1887052	By hand	Um Arda cemeteries(16)	Meroe
25	0540393	1885774	By wheel	Um Arda cemeteries(19)	Meroe
26	0536223	1894607	By wheel	Um Arda cemeteries(29)	Meroe
27	0533841	1886709	By wheel	Um Arda cemeteries(33)	Prehistory
28	0533446	1894086	By hand	Um Arda cemeteries(48)	Prehistory

Thirty-nine pottery samples (Ref/ARC19) were characterized by X-ray diffraction (XRD), thermal analyses (DTA/TG) and X-ray fluorescence spectroscopy. The aim of the work was the deduction of the production technology and provenance of these ceramics.

The observed mineralogical phases were quartz, mica (biotite), potassium feldspar (microcline) and plagioclase (albite and plagioclase).

The XRD report of samples local clays of pottery has yielded the presence of quartz, kaolinite, mica, feldspar and plagioclase. The presence of the broad endothermic peak in the DTA/TG curves of the clays and its absence in the curves of the pottery indicated that the firing temperature of the pottery was above 450 °C, which is the temperature of the kaolinite-meta kaolinite transformation. The firing experiments of the clays between 400-1200 °C in oxidizing atmosphere showed that mica disappeared above 900 °C.

Therefore, the firing temperature of the sherds should have been between 600-900 °C. The chemical correlation between pottery and local clay materials pointed out to a local production of these types of pottery.

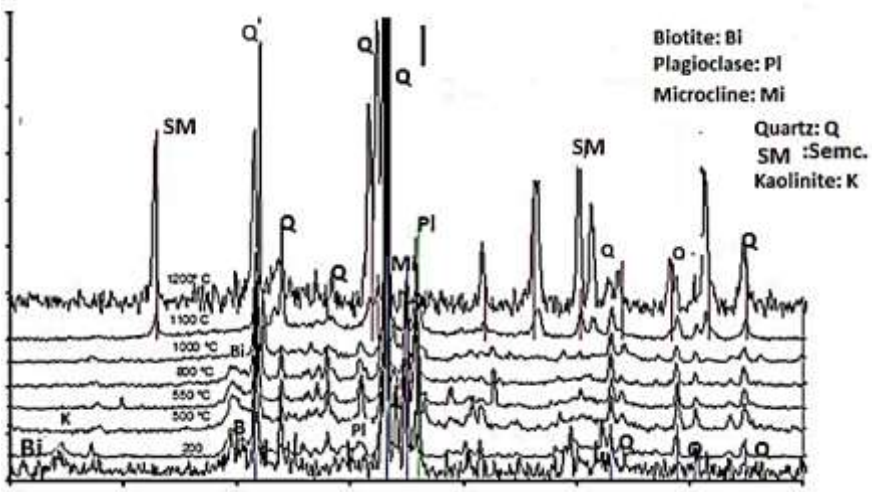

Fig 1:X-ray diffraction patterns of the clay pottery samples
At different temperatures: RT (room temperature) to 1200 ºC.

The characterization of the selected ceramics and clay samples showed that these pottery types formed a homogeneous group in agreement with all the analytical methods. Only one sherd was chemically different from the others.

421between clays and pottery indicated that their chemical compositions were very close. Two possibilities were discussed: the ceramics were either produced from the local clay without

pre-treatment or they were produced from the local clay with a preliminary treatment to diminish the quartz content and to increase the kaolinite content.

The thermal behavior of some pottery suggested that it's more likely or probably added organic materials in the paste to improve the quality of the local clays. The estimation of the firing temperature of the ceramics was based on the presence and absence of some specific mineral assemblages in the clay, fired clays and sherds. Due to the presence of biotite and the absence of kaolinite in all the sherds, the estimated range of the firing temperature of the sherds produced in oxidizing atmosphere was between 600-900 °C whereas the sherds produced in reducing atmosphere were fired in the range of 600-750 °C.

Results:

Table (2): Physico-Chemical Analyses for detected and evaluated concentrations of elements oxides in pottery samples. (Using X-ray diffraction).

NO.	Sample	K_2O %	Na_2O %	MgO %	Al_2O_3 %	SiO_2 %	SO_3 %	CaO %	Fe_2O_3 %
1	W/S/C/W/M3	2.1	1.7	3.8	15.2	66.5	0.81	6.12	0.73
2	W/S/C/N/Q/B6	1.2	1.6	4.4	15.1	64.5	0.60	5.4	4.20
3	W/S/C/W	1.3	1.1	4.4	13.2	61.7	0.50	9.6	5.30
4	W/S/C/W/Q/B8	1.2	0.98	4.2	14.3	64.5	0.50	8.7	0.50
5	W/S/C/W/Q/B7	1.2	1.4	4.3	13.4	62.1	0.30	9.2	0.60
6	W/S/C/W/Q/B8	1.1	1.2	4.2	13.9	62.1	0.60	10.1	0.20
7	W/S/C/W/Q/B9	1.4	2.2	4.5	14.1	60.2	0.20	12.6	3.20
8	W/S/C/W/Q/B7	1.5	3.0	4.6	12.8	62.2	0.40	12.3	4.50
9	W/S/C/W/Q/B5	1.6	1.4	4.7	11.9	62.3	0.50	13.2	5.6
10	W/S/C/W/Q/B4	1.4	1.3	4.5	14.8	62.5	0.40	14.5	5.30
11	W/S/C/W/Q/B6	1.5	2.1	6.4	13.3	62.4	0.40	13.9	6.20
12	W/S/C/W/Q/B9	1.3	2.1	5.3	14.2	62.5	0.40	13.8	7.10
13	W/S/Q/B4/H1	1.2	2.3	5.4	16.1	62.6	0.50	13.6	5.50
14	W/S/Q/B4/SH	1.2	1.5	6.1	15.5	62.6	0.60	14.5	5.50
15	W/S/Q/B4/ /G	1.2	1.6	4.5	15.5	62.1	0.60	14.7	5.30

NO.	Sample	K_2O %	Na_2O %	MgO %	Al_2O_3 %	SiO_2 %	SO_3 %	CaO %	Fe_2O_3 %
16	W/S/C/W/M3	1.2	1.7	5.2	16.8	60.2	0.60	16.2	5.50
17	W/S/C/W	1.1	1.8	4.6	13.2	61.2	0.40	15.2	6.10
18	W/S/W/C/H	1.3	2.3	5.1	11.2	61.8	0.40	14.2	6.70
19	W/S/C/W/M3	1.3	2.4	5.2	11.5	63.4	0.50	13.5	5.60
20	W/S/C/W/S4	1.2	2.5	5.6	10.6	64.4	0.50	13.5	7.60
21	W/S/HM/GJ/C	1.4	2.3	5.7	16.4	62.2	0.60	13.7	6.30
22	W/S/UM/Ar/C48	1.3	1.8	5.4	16.5	63.2	0.50	12.7	6.40
23	W/S/UM/Ar/C19	1.5	2.1	4.6	16.3	62.3	0.70	13.2	6.00
24	W/S/UM/Ar/C29	1.2	2.3	4.7	16.4	63.4	0.70	14.3	5.10
25	W/S/UM/Ar/C33	1.3	2.2	4.8	16.5	62.4	0.60	13.5	6.60
26	W/S/UM/Ar/C16	1.5	2.4	4.4	15.2	61.2	0.70	14.8	6.50
27	W/S/N/Q/Bn/c17	1.5	2.6	4.6	14.8	60.5	1.01	14.2	6.40
28	W/S/Q/B4/F1	1.5	2.1	5.1	14.3	62.2	0.80	14.3	6.20
29	W/S/	1.1	1.9	5.2	10.6	62.1	0.60	14.2	5.40
30	W/S/N/SS/A/C1	1.2	2.4	5.3	14.3	62.3	1.60	14.2	5.40
31	W/S/N/S/A/CS1	1.1	2.3	5.6	15.2	62.3	0.60	15.1	5.30
32	W/S/Q/Bu/F1	1.1	1.7	5.2	15.3	62.3	0.60	15.4	4.20
33	W/S/Q/Bu/C7	1.2	2.4	5.4	15.1	62.2	0.50	15.4	4.30
34	W/S/QB/1	1.3	2.3	5.1	15.2	62.4	0.50	15.3	4.20
35	W/S/C/W/S/3	1.5	2.2	5.4	14.3	62.5	0.60	15.5	4.50
36	W/S/M+/FB	1.4	1.6	5.4	14.2	63.3	0.60	14.2	4.60
37	W/S/N/MF/C11	1.6	2.4	5.3	14.5	63.5	0.60	14.2	3.20
38	W/S/C/W/Q/B6	1.2	2.6	5.4	15.1	62.2	0.60	14.3	4.60
39	W/S/C/W/Q/B6	1.2	2.5	5.1	14.3	61.1	0.50	14.5	5.10

Table (3): Physico-Chemical Analyses for detected and evaluated concentrations of elements in pottery samples. (Using X-ray diffraction).

NO.	Sample	P Ppm	Ti Ppm	Mn ppm	CO ppm	Cu Ppm
1	W/S/C/W/M3	481	ND	176	ND	112
2	W/S/C/N/Q/B6	372	ND	165	ND	112
3	W/S/C/W	371	ND	164	ND	109
4	W/S/C/W/Q/B8	372	ND	165	ND	108
5	W/S/C/W/Q/B7	371	ND	163	ND	106
6	W/S/C/W/Q/B8	370	ND	164	ND	107
7	W/S/C/W/Q/B9	370	ND	165	ND	101
8	W/S/C/W/Q/B7	372	ND	165	ND	97
9	W/S/C/W/Q/B5	372	ND	164	ND	67
10	W/S/C/W/Q/B4	371	ND	165	ND	95
11	W/S/C/W/Q/B6	371	ND	165	ND	85
12	W/S/C/W/Q/B9	371	ND	164	ND	87
13	W/S/Q/B4/H1	372	ND	163	ND	88
14	W/S/Q/B4/SH	371	ND	165	ND	88
15	W/S/Q/B4/ /G	371	ND	165	ND	85
16	W/S/C/W/M3	371	ND	165	ND	88
17	W/S/C/W	371	ND	165	ND	87
18	W/S/W/C/H	371	ND	165	ND	87
19	W/S/C/W/M3	372	ND	165	ND	85
20	W/S/C/W/S4	370	ND	165	ND	94
21	W/S/HM/GJ/C	370	ND	165	ND	100
22	W/S/UM/Ar/C48	370	ND	165	ND	101
23	W/S/UM/Ar/C19	371	ND	165	ND	102
24	W/S/UM/Ar/C29	371	ND	165	ND	97
25	W/S/UM/Ar/C33	371	ND	165	ND	85
26	W/S/UM/Ar/C16	371	ND	165	ND	84
27	W/S/N/Q/Bn/c17	372	ND	165	ND	84
28	W/S/Q/B4/F1	373	ND	165	ND	83

NO.	Sample	P Ppm	Ti Ppm	Mn ppm	CO ppm	Cu Ppm
29	W/S/	372	ND	165	ND	83
30	W/S/N/SS/A/C1	372	ND	165	ND	82
31	W/S/N/S/A/CS1	371	ND	165	ND	81
32	W/S/Q/Bu/F1	371	ND	165	ND	82
33	W/S/Q/Bu/C7	372	ND	165	ND	92
34	W/S/QB/1	372	ND	165	ND	87
35	W/S/C/W/S/3	371	ND	165	ND	86
36	W/S/M+/FB	371	ND	165	ND	85
37	W/S/N/MF/C11	371	ND	165	ND	87
38	W/S/C/W/Q/B6	371	ND	165	ND	86
39	W/S/C/W/Q/B6	372	ND	165	ND	82

Table (4): Physico-Chemical Analyses for detected components in pottery samples. (Using X-ray diffraction).

NO.	Sample	Hornblendes	Hematite	Kaolinite	Muscovite	Quartz	Dolomite	Calcite
1	W/S/C/W/M3	+	+	+	+	+	+	+
2	W/S/C/N/Q/B6	+	+	+	+	+	+	+
3	W/S/C/W	-	-	-	-	-	-	-
4	W/S/C/W/Q/B8	+	+	+	+	+	+	+
5	W/S/C/W/Q/B7	+	+	+	+	+	+	+
6	W/S/C/W/Q/B8	+	+	+	+	+	+	+
7	W/S/C/W/Q/B9	+	+	+	+	+	+	+
8	W/S/C/W/Q/B7	+	+	+	+	+	+	+
9	W/S/C/W/Q/B5	+	+	+	+	+	+	+
10	W/S/C/W/Q/B4	+	+	+	+	+	+	+
11	W/S/C/W/Q/B6	+	+	+	+	+	+	+
12	W/S/C/W/Q/B9	+	+	+	+	+	+	+

NO.	Sample	Hornblendes	Hematite	Kaolinite	Muscovite	Quartz	Dolomite	Calcite
13	W/S/Q/B4/H1	+	+	+	+	+	+	+
14	W/S/Q/B4/SH	−	−	−	−	−	-	-
15	W/S/Q/B4/ /G	−	−	−	−	−	−	−
16	W/S/C/W/M3	+	+	+	+	+	+	+
17	W/S/C/W	−	−	−	−	−	−	−
18	W/S/W/C/H	−	−	−	−	−	−	−
19	W/S/C/W/M3	+	+	+	+	+	+	+
20	W/S/C/W/S4	+	+	+	+	+	+	+
21	W/S/HM/GJ/C	−	−	−	−	−	−	−
22	W/S/UM/Ar/C48	+	+	+	+	+	+	+
23	W/S/UM/Ar/C19	+	+	+	+	+	+	+
24	W/S/UM/Ar/C29	+	+	+	+	+	+	+
25	W/S/UM/Ar/C33	+	+	+	+	+	+	+
26	W/S/UM/Ar/C16	+	+	+	+	+	+	+
27	W/S/N/Q/Bn/c17	+	+	+	+	+	+	+
28	W/S/Q/B4/F1	+	+	+	+	+	+	+
29	W/S/	−	−	−	−	−	−	−
30	W/S/N/SS/A/C1	+	+	+	+	+	+	+
31	W/S/N/S/A/CS1	+	+	+	+	+	+	+
32	W/S/Q/Bu/F1	+	+	+	+	+	+	+
33	W/S/Q/Bu/C7	+	+	+	+	+	+	+
34	W/S/QB/1	+	+	+	+	+	+	+
35	W/S/C/W/S/3	+	+	+	+	+	+	+
36	W/S/M+/FB	-	-	-	-	-	-	-
37	W/S/N/MF/C11	+	+	+	+	+	+	+
38	W/S/C/W/Q/B6	+	+	+	+	+	+	+
39	W/S/C/W/Q/B6	+	+	+	+	+	+	+

Conclusions:

The results of XRD and XRFS analyses, in addition to the availability of suitable clays for pottery manufacturing in some valleys of the region, which are still practiced in the area, confirm the possibility that the pottery samples collected from the archaeological sites in question were locally made in the region and not brought from elsewhere .On the other hand, the thermal analyses (DTA/TG) of the pottery samples suggest that the firing index is high and the temperature in the magnitude of 600-900C.These high temperature degrees could not be obtained in the ancient times in the absence of forced –draft kilns without frequent fueling and partial control of firing temperature and atmosphere. It also seems to postulate the use of similar techniques by the varied human groups inhabited this area(from Almatamma to Gouz Burra) during a long period of time and hence raising the probability that the owners of these archaeological sites could belong to the same cultural tradition.

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