Analysis of elemental composition, fabrication texture and inclusions in pottery samples from Vashtemia, site of the Early Neolithic period in Albania.

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Abstract

- A necessary expansion of the study on human behaviour and social organization in prehistoric periods leads us to study in more detail the elemental composition of the materials the products of human activity, such as ceramics, were made of.

- It takes the main place in the production of this period and its analysis helps us to know more about the advancement of production technologies and shed light on the origin of clay sources.

- From the Vashtemia site, a number of samples have been selected for analysis, by means of different techniques, in order to identify the raw materials used for the production of ceramic vessels, the technique of surface processing, the style of decoration and also to understand the construction of the furnaces used for clay firing, starting from the characterization of the mineral phases of the ceramics that we studied.

Historical background

- The Neolithic settlement of Vashtemia is located on a flat alluvial plain, at the western edge of the village of the same name, on the right side of the Korçë-Maliq road in Albania.

- The first information on this settlement dates back to 1972, which was followed by a control excavation in 1973 and systematic excavations in 1974.

View of the Neolithic site of Vashtemisa (photo A. Bunguri 2011)

Historical background

- Ceramics appear abundant throughout the layer depth and are represented by several categories such as:
  - bright red monochrome pottery,
  - painted pottery,
  - monochrome gray black pottery,
  - impresso pottery and barbotine,
  - the latter quite limited.

Texture analysis

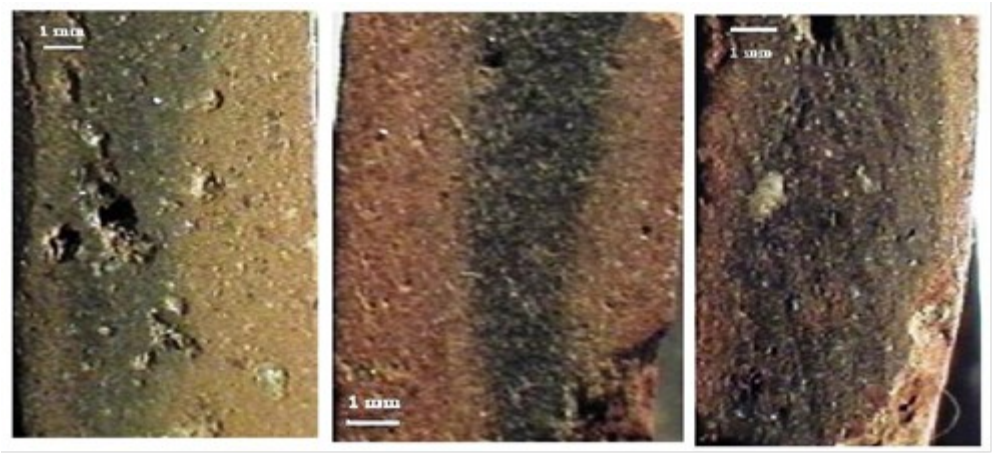
- The group of samples taken in the study from the Vashtemia site includes 31 samples of which 14 belong to thin-walled ceramics and the rest are from thick-walled ceramics.

- Samples are not cataloged. Among them, the main place is occupied by light red fragments, usually with a weak glaze and a small number have remnants of decorations on the surface

View of the pottery group from the Vashtemia site.

Texture analysis

- The baking is not complete, which is also evidenced by the non-uniform color, especially in the cross-section, where in almost all samples the existence of a dark band between the two side bands of red color can be observed. Many authors explain this with baking conditions.



Cross-sectional view of some ceramics from Vashtemia taken by μ-FRX.

The study of elemental composition

- The table shows the results of the elemental composition of the samples analyzed by the X-Ray Fluorescence method, as well as of some clay samples collected around the Vashtemia site.

- They are collected by archaeologists and represent soils collected in different layers of the excavation.

- The identification of clay sources in the Korça area is quite difficult due to the great changes that the terrain has undergone with the drying of the Maliqi marsh, around which all the early settlements in this area were located.

The study of elemental composition

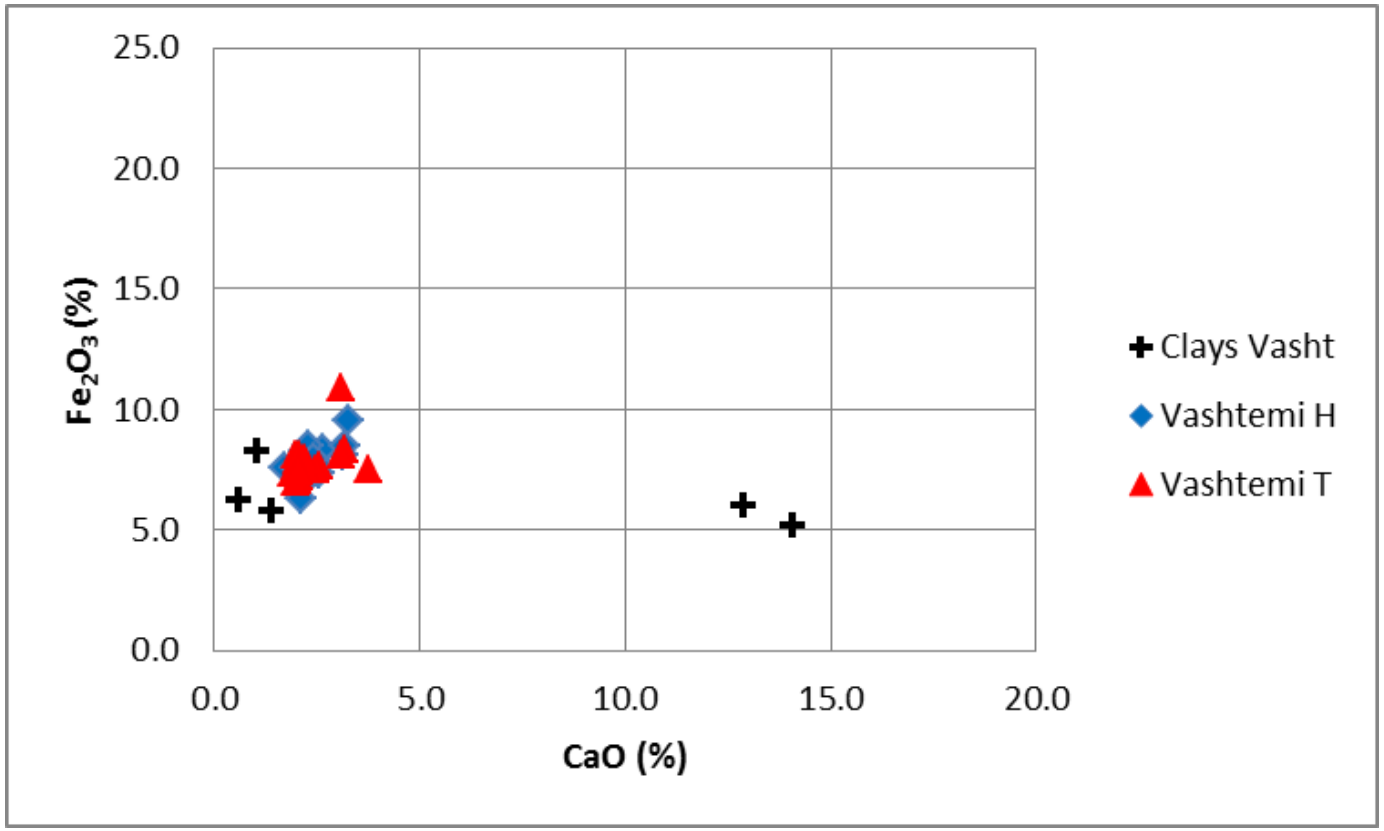
Data on the content of major elements testify to a group of samples with similar composition.

- The content of K_2O varies between 1.3 – 2.5%,
- CaO between 1.7 – 3.7%,
- TiO_2 0.6 – 1%
- Fe_2O_3 6.3 – 10.9%.

Three of the clay samples have content of major elements close to those of ceramics, while the other two have different compositions, especially high content of CaO, which is not found in any of the samples.

The content of major elements (%) in the ceramics and clays of Vashtemia

Sample Code	K_2O	CaO	TiO_2	Fe_2O_3		Sample Code	K_2O	CaO	TiO_2	Fe_2O_3
MVT-1	2.24	3.07	0.72	10.86		MVH-1	2.55	1.72	0.90	7.57
MVT-2	1.89	2.57	0.65	7.67		MVH-2	2.13	2.10	0.85	6.86
MVT-3	1.80	2.06	0.69	8.14		MVH-3	2.30	2.53	0.80	7.76
MVT-4	2.14	2.26	0.91	7.72		MVH-4	2.41	3.11	0.94	8.14
MVT-5	2.30	3.16	0.90	8.36		MVH-5	2.11	1.98	0.93	7.59
MVT-6	2.39	1.89	0.79	7.37		MVH-6	1.97	2.56	0.69	7.33
MVT-7	1.96	2.48	0.74	7.54		MHV-7	2.32	2.64	0.85	8.34
MVT-8	1.83	1.98	0.74	8.13		MVH-8	2.13	3.16	0.72	8.52
MVT-9	1.84	2.00	0.65	7.90		MVH-9	2.07	3.25	0.74	9.57
MVT-10	2.26	2.23	0.99	7.54		MVH-10	2.08	2.13	0.83	6.29
MVT-11	2.14	2.07	0.92	7.24		MVH-11	2.09	2.29	0.94	7.42
MVT-12	2.21	2.01	0.93	7.03		MVH-12	2.53	2.22	0.94	8.23
MVT-13	1.28	1.98	0.89	6.94		MVH-13	2.42	2.28	0.97	8.52
MVT-14	2.21	3.08	0.90	8.10		MVH-14	2.14	2.41	0.84	7.99
MVT-15	2.14	3.73	0.74	7.52						
MVT-16	2.04	2.20	0.85	7.94		Vasht Ag1	2.66	1.41	0.84	5.77
MVT-17	2.36	2.07	0.99	7.42		Vasht 500	3.12	14.07	0.64	5.17
						Vasht 501	2.31	1.04	0.79	8.26
						Vasht 502	2.42	12.87	0.61	6.03



CaO – Fe2O3 graph for the ceramics and clays of the Vashtemia site

The content of minor elements (mg/kg) in the ceramics and clays of the Vashtemia site.

Sample Code	V	Cr	Mn	Ni	Cu	Zn	Ga	Rb	Sr	Y	Zr	Pb	Th	Ba	La	Ce	Nd
MVH-1	186	239	929	137	27	136	18	130	170	40	300	28	15	872	30	74	27
MVH-2	167	185	592	110	20	103	19	118	192	30	247	27	13	978	20	49	22
MVH-3	189	303	867	156	26	130	18	104	199	38	242	27	18	1153	21	63	24
MVH-4	134	238	1233	120	32	132	26	111	222	38	267	28	13	1021	26	73	26
MVH-5	201	156	794	121	27	110	21	113	178	28	260	28	16	970	17	64	22
MVH-6	237	151	862	129	22	98	16	87	206	54	142	16	16	1060	28	64	34
MHV-7	96	218	1044	135	35	134	23	112	248	43	269	49	12	1038	28	76	28
MVH-8	163	235	666	153	24	121	17	106	203	39	186	41	12	896	28	70	24
MVH-9	300	149	760	123	20	125	18	86	278	42	123	13	15	1107	26	61	31
MVH-10	209	409	899	151	26	123	15	116	211	30	202	14	18	1078	17	57	15
MVH-11	285	268	1032	96	17	100	19	101	224	38	261	16	18	1086	28	68	23
MVH-12	222	302	1219	156	29	139	21	122	200	46	277	34	18	927	29	78	23
MVH-13	274	280	1196	139	15	132	19	121	201	43	250	18	22	924	32	80	25
MVH-14	228	255	844	114	22	124	20	116	202	36	243	23	19	976	30	66	25
MVT-1	184	204	801	130	32	146	15	101	180	34	167	13	14	884	22	60	29
MVT-2	166	169	918	134	29	95	20	85	199	51	120	12	17	819	25	65	34
MVT-3	160	1226	1023	476	36	109	16	75	178	23	176	43	6	840	11	46	14
MVT-4	224	158	704	113	21	110	23	119	185	34	229	31	17	928	22	60	19
MVT-5	223	160	962	117	32	105	20	108	205	44	302	42	12	880	26	67	18
MVT-6	261	134	916	123	36	124	26	109	190	31	234	23	9	954	17	57	22
MVT-7	217	482	858	214	25	110	14	81	213	34	160	19	15	1001	19	53	25
MVT-8	166	452	959	225	29	97	20	81	170	38	175	23	15	702	19	54	27
MVT-9	246	1351	1037	457	36	112	7	75	180	24	168	10	14	853	11	45	19
MVT-10	213	648	1062	122	22	126	23	121	212	32	300	31	15	945	24	73	21
MVT-11	269	139	731	116	30	101	25	106	196	33	262	36	15	1032	17	61	24
MVT-12	161	308	704	112	21	107	18	102	182	30	256	47	15	1029	20	58	23
MVT-13	193	196	694	105	13	102	17	105	182	29	276	18	20	1034	23	62	25
MVT-14	138	189	998	110	22	103	20	108	205	40	258	40	19	876	28	72	33
MVT-15	236	210	952	113	21	99	20	96	223	36	174	16	16	890	25	64	25
MVT-16	151	335	748	128	24	113	25	118	187	36	237	29	15	905	28	66	27
MVT-17	230	316	1038	123	20	122	23	116	213	34	309	34	15	945	22	75	28
Vasht Ag1	328	597	958	118	13	90	4	123	91	31	279	39	8	531	38	78	37
Vasht 500	318	255	546	106	16	106	5	129	277	27	232	41	11	621	34	55	28
Vasht 501	455	926	995	586	17	79	8	119	56	31	198	43	10	343	30	60	30
Vasht 502	209	575	711	391	11	71	3	92	173	24	184	30	8	263	30	49	22

Mineralogical composition

- Information on the mineralogical composition of the ceramics is mainly based on the petrographic and X-ray diffraction study of a limited number of samples from this site.

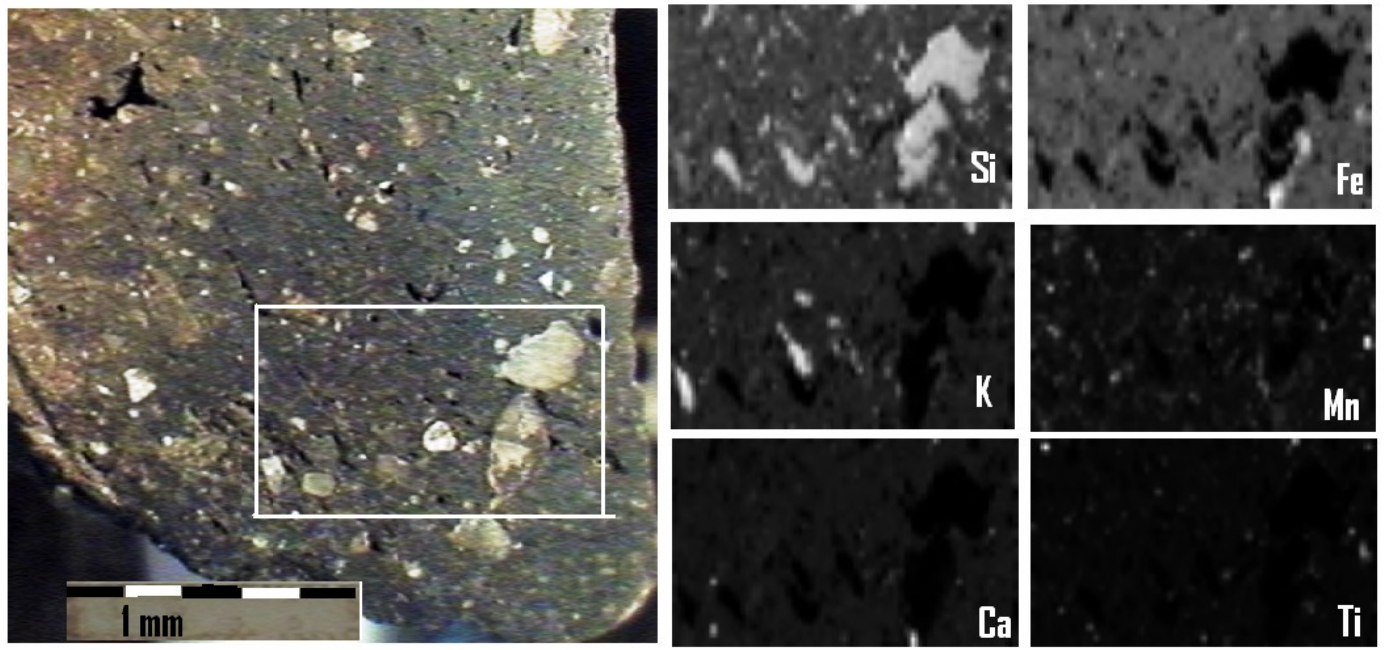
- It is noted that among the observed inclusions, those rich in Si predominate, which should be quartz particles. In smaller quantities, particles rich in K, Ca and Fe were also observed.

- As expected from the overall low CaO content of the ceramics, the amount of Ca-rich particles is relatively low.

- Through these measurements it is not possible to distinguish whether the observed inclusions were part of the clay or related to the materials added as temper during the pottery production, although the particles with larger dimensions must have been added as temper.

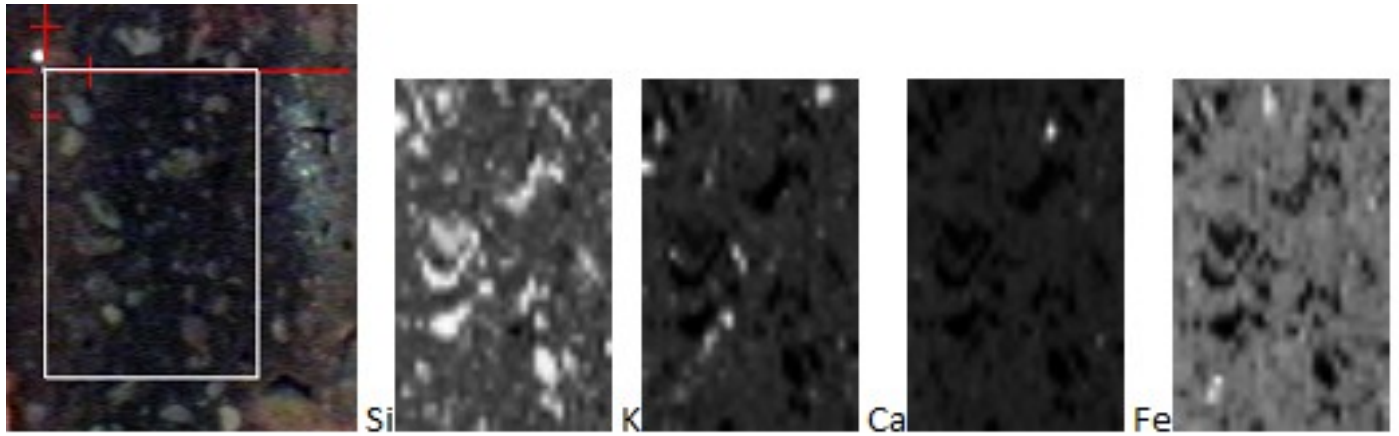
Distribution maps of major elements in the inclusions of ceramic samples from the Vashtemia site

MVT -16

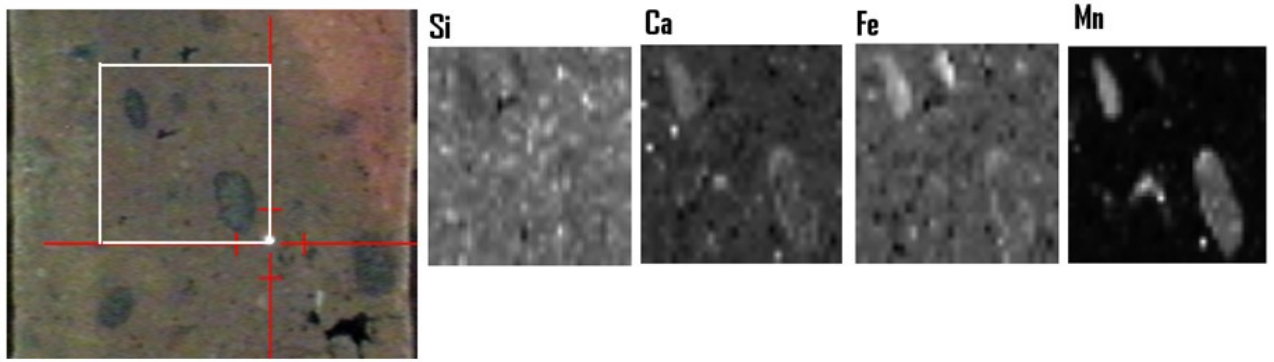


Distribution maps of major elements in the inclusions of ceramic samples from the Vashtemia site

MVT-5



MVH-8

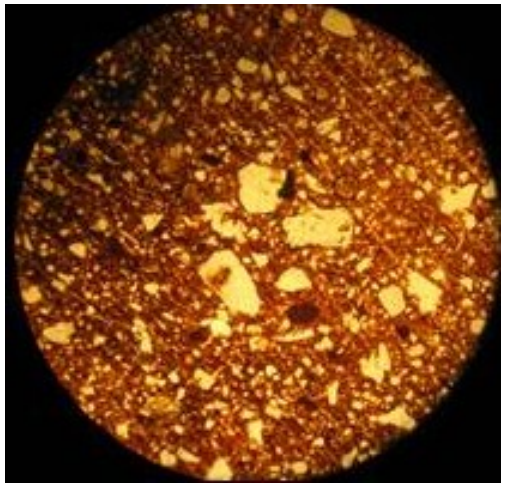
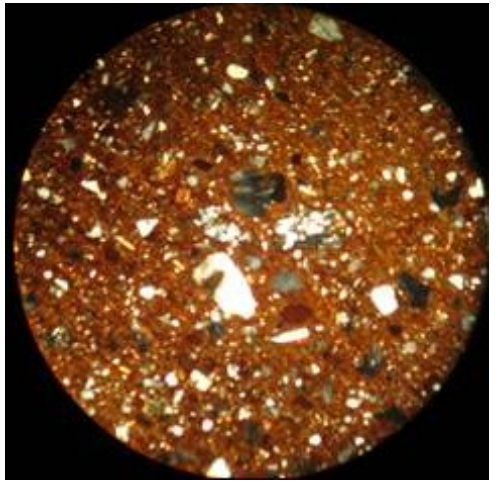


Petrographic Study

Sample V/11. The matrix (without analyzer) is presented with a reddish color, which is more intense in the center and paler in the periphery, a fact that speaks of a "sandwich" type structure, with good sorting, anisotropic.

Aplastic material is represented by a) minerals: granular quartz, plagioclase and mica (biotite muscovite) as well as b) rock fragments (lithoclasts): metamorphosed quartzites, serpentinites, amphibolic schists, biomicrites and hematitic pellets. Aplastic material ranges from highly angular (abrasive) to poorly rounded.

Gaps: lens-shaped gaps.

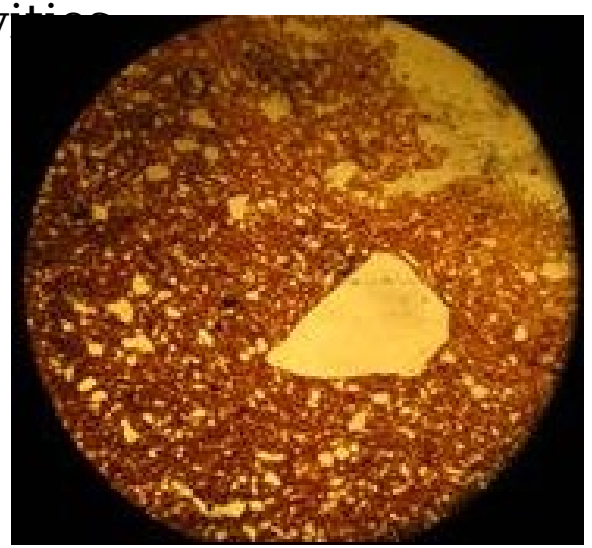
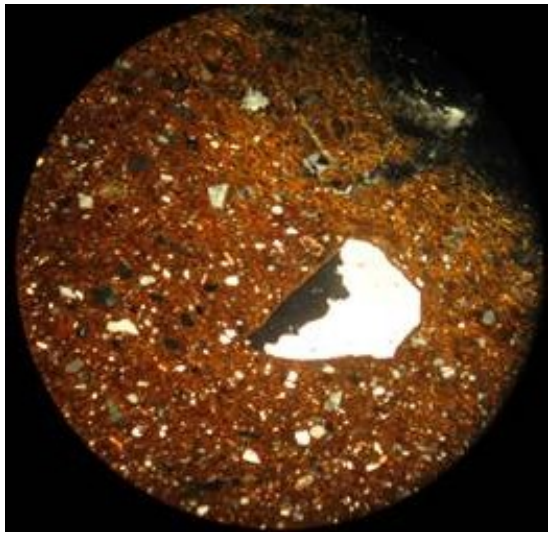
a)  b) 

Analysis of sample V/11 with a polarized light microscope (x10)

a) (parallel polars=PPL, and b) crossed polars (=+PL).

Petrographic Study

- **Sample V/2.** The matrix (without analyzer) is presented with a reddish color, which is more intense in the center and paler in the periphery, a fact that speaks of a "sandwich" type structure, with very good sorting, anisotropic.
- Aplastic material is represented by a) minerals: granular quartz, plagioclase and mica (biotite muscovite) as well as b) rock fragments (lithoclasts): polygranular quartz, amphibolic schists, biomicrites and hematitic pellets.
- Aplastic material ranges from highly angular (abrasive) to poorly rounded, grainy. Carbonate recrystallization material is evidenced.
- Voids: lenticular voids, but also cavities.

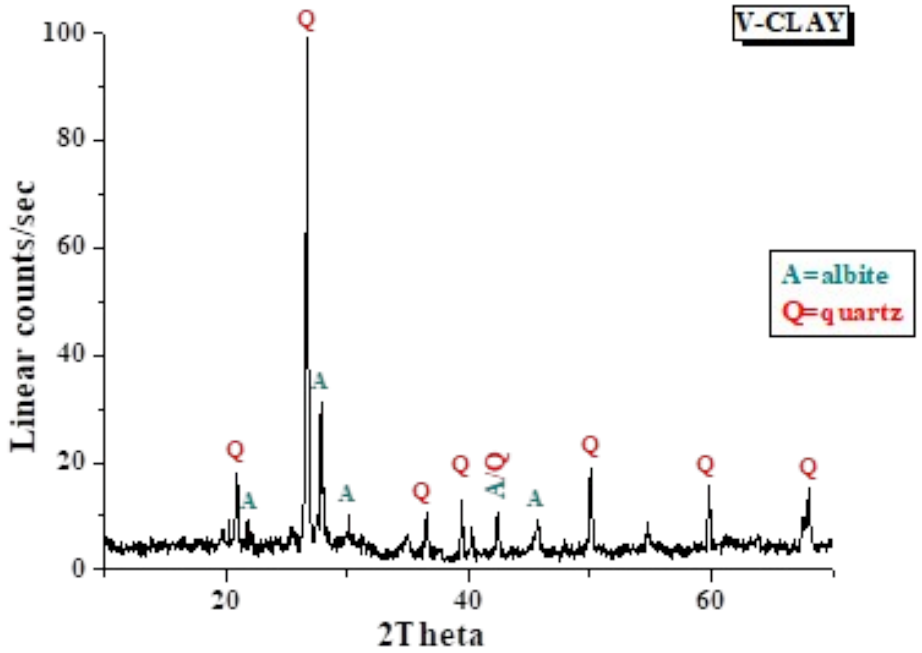
a)  b) 

Analysis of sample V/2 with a polarized light microscope (x10)

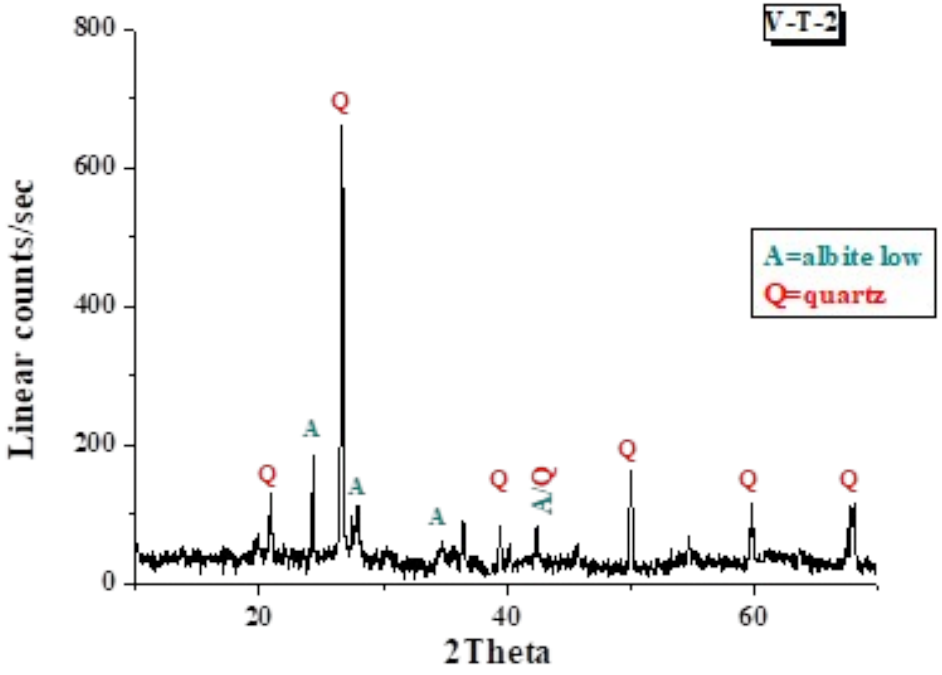
a) (parallel polars=PPL, and b) crossed polars (=+PL).

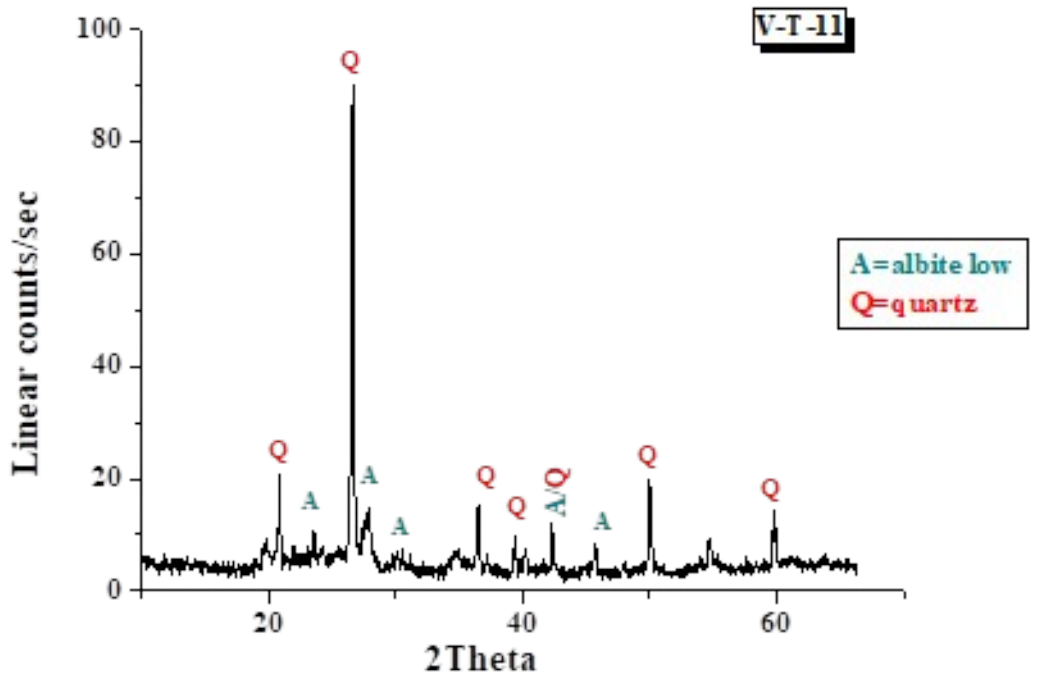
X-ray diffractometry analyses

- The main phases identified by the X-ray diffraction method in the analyzed ceramic and clay samples are quartz (SiO_2) and albite ($NaAlSi_3O_8$). These results agree with the results obtained from the petrographic study as well as those with µ-XRF, which have identified minerals containing these phases.
- We think that the low sensitivity of the XRD method does not allow the identification of some minor minerals that have been observed by the petrographic study.



XRD spectrum of clay from the Vashtemia site.





XRD spectrum of two ceramic samples from the Vashtemia site.

Conclusions

- Since the CaO content in the ceramic samples from the Vashtemia site is lower than 5%, it follows that the clays used are of the low-calcium (non-calcareous) type.

- Comparing the composition of thin-walled ceramics with those with thick walls, testifies to similar raw materials used for each group.

- Thus, both the average values of the groups and the variation of the values do not show any significant difference.

Conclusions

- Petrographic analysis shows low degree of vitrification and presence of recrystallized carbonates. These data suggest baking in an oxidizing environment (open oven or closed oven with final oxidizing stage) and moderate temperature for a short time.

- The presence of the same main phases, quartz and albite, with similar intensities both in the samples and in the clay suggest low reactivity of the mineral phases due to low temperatures of the order of 700 - 750°C.

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