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Archaeometric study of sub-geometric pottery found in Potenza, Italy: relationship and trade between near indigenous centers

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abStRaCt - twenty pottery fragments from indigenous sites of torre di Satriano and baragiano (pZ, italy) were studied using combined analytical techniques (oM, pXRD, XRF and SEM) to characterize their production centers and to better understand their manufacturing processes. analyzed ceramics, characterized by a sub-geometrical decoration, are dated to Vi sec. b.C. when a wide local pottery production was associated to a homogeneous phenomenon of diffusion of greek products.

torre di Satriano and baragiano ceramics show similar petrographic features. two groups are distinguished, a "less fine" group 1 and a "more fine" group 2. Mineralogical and morphological analyses suggest a firing temperature higher than 850°C as confirmed by the high degree of the groundmass vitrification. the chemical similarities between the pottery of group 1 and the clay samples collected around the archaeological sites (lucanian basin sediments), might suggest a local provenance. Furthermore, the finest ceramic of group 2 may have been locally produced following selection and levigation processes of the clayey materials. However, the chemical composition of the group 2 ceramics may be related to a different raw material source-area. only one fragment may be excluded from local production since it shows a different composition corroborating the archaeological hypothesis.

RiaSSunto - nel seguente lavoro sono stati analizzati venti frammenti di ceramica datati al Vi sec. a.C. e rinvenuti nei siti lucani di torre di Satriano e di baragiano, ubicati nell'area archeologica di potenza. Si tratta di insediamenti indigeni, la cui posizione geografica ha favorito, sin dal Vii sec. a.C., relazioni privilegiate con i coloni greci e con gli altri centri indigeni vicini. Si rinvengono infatti in tutto il cantone nord lucano, prodotti locali dalle caratteristiche omogenee, di forma e decorazione sub geometrica, oltre a prodotti di chiara provenienza coloniale.

le analisi petrografiche (oM), mineralogiche (pXRD), chimiche (XRF) e morfologiche (SEM) eseguite sulle ceramiche rappresentative dai due centri archeologici, hanno permesso di ottenere informazioni riguardanti la provenienza e la tecnologia di produzione. Sulla base delle caratteristiche petrografiche, sono stati distinti due gruppi: il gruppo 1 delle ceramiche "meno fini" e il gruppo 2 delle ceramiche "più fini". il gruppo 1 mostra maggiore similarità chimica con le argille plioceniche campionate in prossimità dei siti archeologici, suggerendo una produzione locale. le differenze riscontrate per quanto riguarda le ceramiche del gruppo 2, potrebbero essere legate ad un più accurato processo di lavorazione oppure all'utilizzo di altro materiale argilloso presente nella zona. Solo un campione, che ha mostrato un comportamento chimico diverso rispetto agli altri frammenti, può essere considerato non locale avvalorando le ipotesi archeologiche.

lo studio morfologico eseguito sulla matrice dei frammenti ceramici e la composizione mineralogica, suggeriscono temperature di cottura superiori a 850°C.

KEy woRDS*: Ceramics; North-lucanian area; Provenance; Technology; XRF.*

intRoDuCtion

the ancient history of basilicata region has been strongly influenced by the characteristics of its territory. Springs, lakes, river valleys and sea allowed, since prehistoric times, the human settlements and the relationships among people of different cultures.

the iron age (iX-Viii century b.C.), was characterized by the development of homogeneous cultures, with the same behavior and technological patterns like the funeral ritual or decoration vascular (nava, 1999).

greek sources testify that the north western lucanian area was occupied by the *Peuketiantes* people, a near *ethnos* of *Enotri* people, characterized by the diffusion of the *North-Lucanian* ceramic among neighboring production centers.

the "torre di Satriano" and "baragiano" indigenous sites, from the end of the seventh century b.C., coeval to the Metaponto town institution, evidenced a growing local ceramic production associated with a homogeneous phenomenon of diffusion of greek products (Russo, 2008).

torre di Satriano, located on a hill (about 20 km from potenza), is an important reference point for the surrounding landscape (Fig. 1). the first discoveries in the area date back to 1943 and cover a large time span from the Middle bronze age to Middle age (Di lieto, 2005).

the indigenous center of baragiano (about 30 km from potenza), is located in a strategic geographic position in a wide valley and at the confluence of two rivers i.e. the avigliano River, to north-west and the picerno River, to north-east (Fig.1). the finds include the ceramics dating from the Vii-Vi sec. b.C. to the third century b.C. (osanna, 2004).

in this preliminary work, twenty pottery fragments found in the two above-mentioned indigenous centers were analyzed, in order to obtain information on the provenance and characteristics of ceramic production. For this purpose, several clayey samples, collected in different areas of the lucanian basin (potenza, baragiano and tito area), were analyzed to characterize the source-area.

MatERialS anD MEtHoDS

Ceramic fragments and raw-material samples

twenty ceramic fragments from the two archaeological sites described above (torre di Satriano and baragiano) were analyzed. the samples (Fig. 2), dated to Vi sec. b.C., consist of potsherds of differing shape and size, characterized by sub-geometrical decoration with red and brown panels and vertical and horizontal lines.

the ceramic shapes are typical containers for pouring liquids such as the pitchers and *Kantharos*, and for ointments as *olle* and *kantharoi*.

Fourteen samples were selected (ts 1-14) from the torre di Satriano archaeological site and six samples from the baragiano (b 1-6) archaeological site. they were considered local production by archaeologists; only the ts14 and b4 samples were attributed to a colonial provenance (osanna *et al*., 2008). Characteristics of the ceramics samples are summarized in table 1.

Fine-grained raw materials were collected from the geological formations close to the archaeological sites, to compare their chemical and mineralogical composition with the torre di Satriano and baragiano ceramic samples.

the clay samples considered for this study characterize the pliocene sedimentary sequence (balduzzi *et al*., 1982; Casnedi *et al*., 1982) of the lucanian basin, which is a paleogeographic unit of the bradanic trough (Ricchetti and Scandone, 1979). the geological formations (Fig. 1) investigated here are represented by sandstone with intercalations of microconglomerates (altavilla unit) and by silty- sands, and silt and blue-grey clays (ariano unit) (Di nocera *et al*.,

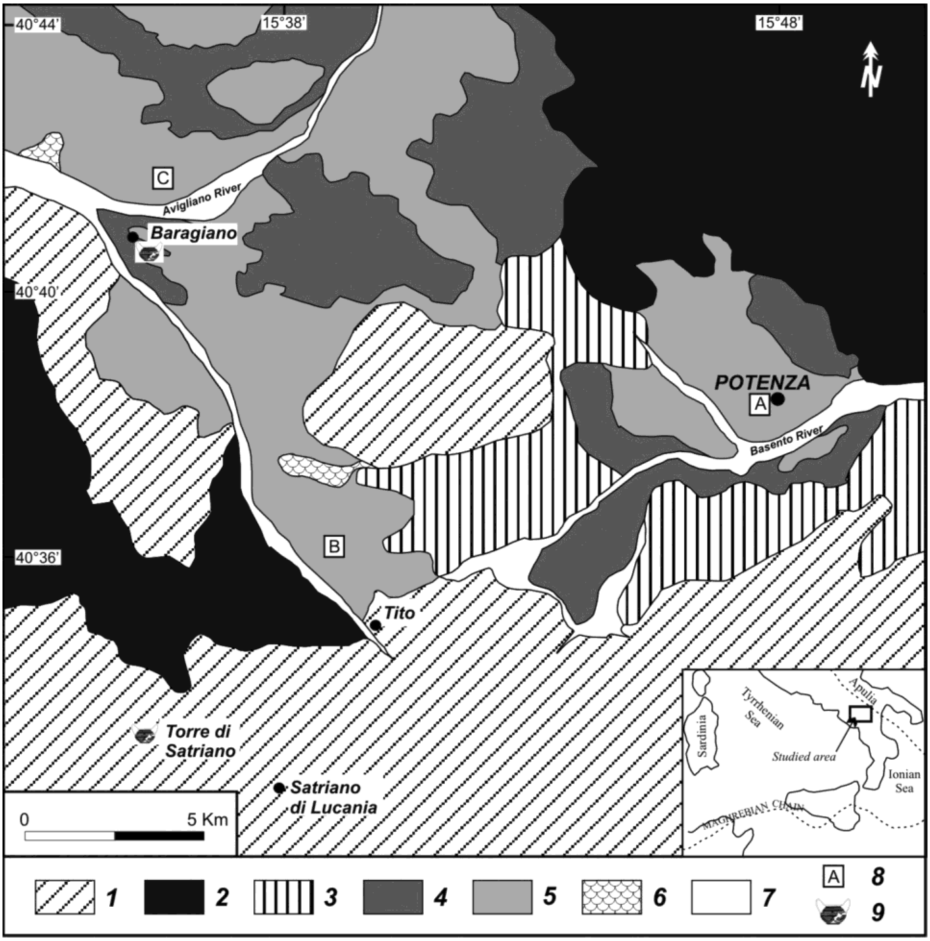

Fig. 1 - geological sketch map of the southern apennines near the potenza area (modified from bonardi *et al*., 1988; Cavalcante *et al*., 2003). 1) lagonegro units (trias-upper Cretaceous); 2) lagonegro units (Flysch Rosso) (upper Cretaceous-oligocene); 3) Sicilide units (Cretaceous-lower Miocene; including argille Varicolori Formation); 4) conglomeratic deposits (pliocene); 5) sand, silt and clay deposits (pliocene); 6) landslide deposits; 7) alluvial deposits; 8) sampling area (a, Samples from potenza town; b, Samples from tito area; C, Samples from baragiano area); 9) archaeological sites.

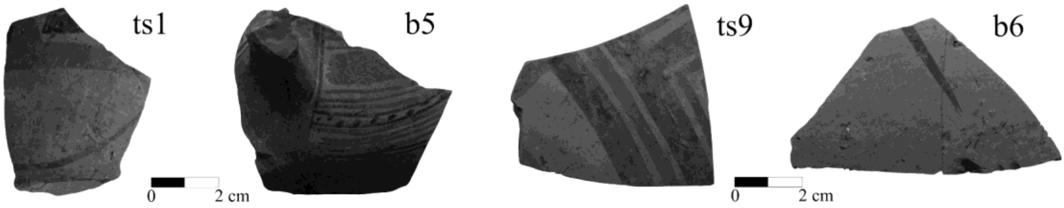

Fig. 2 - Representative photographs of the studied ceramic fragments.

Table 1

Characteristics of the ceramic samples from Torre di Satriano and Baragiano archaeological sites.

Sample	***Age***	***Type***	***Color***	***Provenance***
Torre di Satriano samples				
ts1	Vi sec. b.C.	*olla*	reddish yellow	North-Lucanian area
ts2	Vi sec. b.C.	n.d.	very pale brown	North-Lucanian area
ts3	Vi sec. b.C.	*olla*	light gray	North-Lucanian area
ts4	Vi sec. b.C.	*olla*	light gray	North-Lucanian area
ts5	Vi sec. b.C.	n.d.	pale yellow	North-Lucanian area
ts6	Vi sec. b.C.	n.d.	pale yellow	North-Lucanian area
ts7	Vi sec. b.C.	n.d.	pink	North-Lucanian area
ts8	Vi sec. b.C.	n.d.	reddish yellow	North-Lucanian area
ts9	Vi sec. b.C.	n.d.	very pale brown	North-Lucanian area
ts10	Vi sec. b.C.	n.d.	very pale brown	North-Lucanian area
ts11	Vi sec. b.C.	*olla*	pinkish gray	North-Lucanian area
ts12	Vi sec. b.C.	n.d.	light brownish gray	North-Lucanian area
ts13	Vi sec. b.C.	n.d.	light reddish brown	North-Lucanian area
ts14	Vi sec. b.C.	*ionic cup*	reddish yellow	Colonial area
Baragiano samples				
b1	Vi sec. b.C.	*Kantharos*	reddish yellow	North-Lucanian area
b2	Vi sec. b.C.	*olletta biconica*	very pale brown	Matera town area
b3	Vi sec. b.C.	*pitcher*	reddish yellow	North-Lucanian area
b4	Vi sec. b.C.	*skyphos*	pink	Colonial area
b5	Vi sec. b.C.	*kantharos*	reddish yellow	North-Lucanian area
b6	Vi sec. b.C.	*olla*	light brownish gray	North-Lucanian area

1988). these blue-grey clays consist of silty clay or clayey silt with little sand showing quite homogeneous compositional characteristics (Dell'anna and laviano, 1986). Six samples were collected from the pliocene clayey materials in potenza town (pz 1-6), four samples were collected from pliocene clayey materials close to the tito area (ti 1-4), three samples were collected from pliocene clayey materials close to the baragiano (bg 1-3) area (Fig. 1).

Analytical techniques

both ceramic and clayey samples were studied using combined mineralogical, petrographical, morphological and chemical analytical techniques (XRpD, XRF, oM and SEM only for ceramic samples). petrographic thin-section observations were made under a ZEiSS polarizing microscope. the studied samples were described following the scheme proposed by whitbread (1995), that characterizes the microstructure, groundmass and inclusions. Micro-morphological analyses by scanning electron microscopy (SEM) on the freshly fractured surfaces of all sherds were performed to characterize the groundmass microstructure and the vitrification degree (e.g. Maniatis and tite, 1981; Cultrone *et al.*, 2002). analyses were performed on a FEi Quanta 200 Scanning Electron Microscope equipped with a EDaX genesis 4000.

Mineralogical characterisation of both pottery and clay samples was carried out by X-ray diffraction analysis (XRD) on a bruker D8 advance diffractometer, with CuKα radiation. thin layer from both internal and external surfaces of the sherds, was removed before grinding the ceramic samples. Ceramic and dried clay samples were ground using an agate mill. both ceramic and clay powders were oven-dried at a constant temperature of 105°C for 24 h. X-ray diffraction patterns were taken in the range 5°-60° 2θ, with steps of 0.02° 2θ and step-times of 1 sec/step.

the chemical composition (major and trace elements) was determined on pressed powder disks by X-ray fluorescence spectroscopy (XRF) on a bruker S8 tiger spectrometer. international geological standards were used for calibration. loss on ignition (l.o.i.) was gravimetrically estimated after overnight heating at 950°C.

RESults

Petrographic analysis

the ceramic samples from torre di Satriano and baragiano show quite similar petrographic features for groundmass, microstructure and inclusions (Fig. 3). the fabric is characterised by a purified mixture with few voids showing preferred orientation parallel to the ceramics surface, that suggests a wheel-made production technique. the highly micaceous groundmass is characterized by reddish-brown to orange color and optical activity ranging from medium-low to absent. Remains of microfossils (generally *foraminifera*) and secondary calcite are sometimes observed.

the aplastic inclusions mainly consist of dominant quartz, micas (muscovite and biotite) and variable amounts of feldspar. Some samples (**ts4**, **ts5** and **b1**) contain few small- to medium-sized metamorphic rock fragments (quartzite). grain-size distribution is generally unimodal.

Regarding the grain size, two groups are distinguished: group 1 including **ts2**, **ts3**, **ts4**, **ts5**, **ts6**, **ts7** and **b2** with main grain size ranging from 0.2 to 0.4 mm, and higher inclusion/matrix ratios (Fig. 3 a-b); group 2 including **ts1**, **ts8**, **ts9**, **ts10**, **ts11**, **ts12**, **ts13**, **ts14, b1**, **b3, b4, b5** and **b6** samples with main grain size of about 0.1 mm and low inclusion/matrix ratios (Fig. 3 c-d).

Micro-morphological analysis by SEM

the textural features and the groundmass vitrification degree have been characterized by

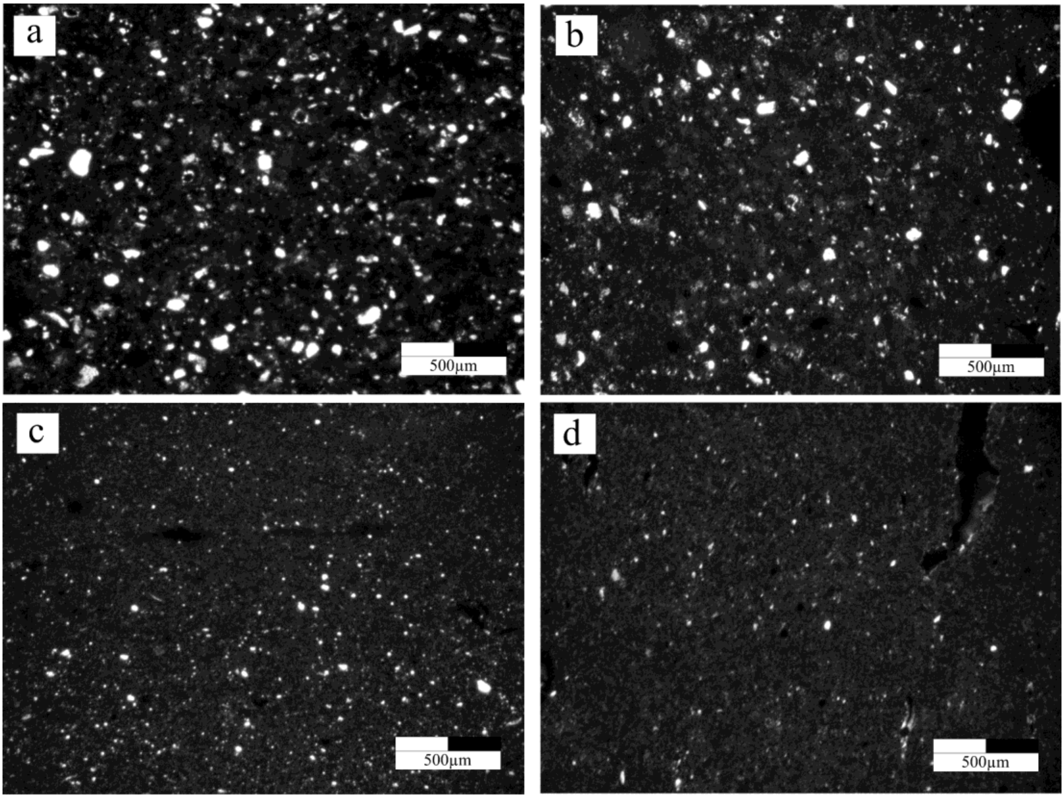

Fig. 3 - Representative microphotographs of the studied sherds. a-b group 1 - "less fine" ceramics (ts4 and b2 samples) - c-d group 2 - "more fine" ceramics (ts10 and b3 samples). Crossed polarized light, magnification 15X.

scanning electron microscopy (SEM). These information, combined with petrographic and mineralogical data, yield a rough estimate of the firing temperatures (e.g. Maniatis and Tite, 1981; Cultrone *et al.*, 2002). Thus, the group 1, identified by petrographic analysis, shows a minor extent of the glassy phase, the laminar habit of phyllosilicates is still preserved and related to an initial vitrification. (Fig. 4a-b). The group 2 instead displays an extensive vitrification with bloating pores (Fig. 4c-d). However on the basis of the groundmass vitrification structure, in comparison with the vitrification stages of Maniatis and Tite (1981), high firing temperatures are suggested for both groups.

XRPD analysis of pottery and clay sediments

Table 2 shows the mineralogical phases identified in each ceramic fragment. Quartz and feldspars are ubiquitous in all samples. Most of the samples contain hematite, gehlenite and diopside whereas micas occur in **ts2**, **ts3**, **ts4**, **ts5**, **ts6**, **ts7**, **ts14**, **b1**, **b2**, **b3** and **b4**. Calcite was detected in **ts2**, **ts6**, **ts7**, **ts14**, **b2**, **b5** and **b6** samples.

The occurrence of calcite in some samples, associated to high-temperature Ca-silicates, is due to secondary deposition during the burial process (Cau Ontiveros *et al.*, 2002), as also suggested by petrographic study.

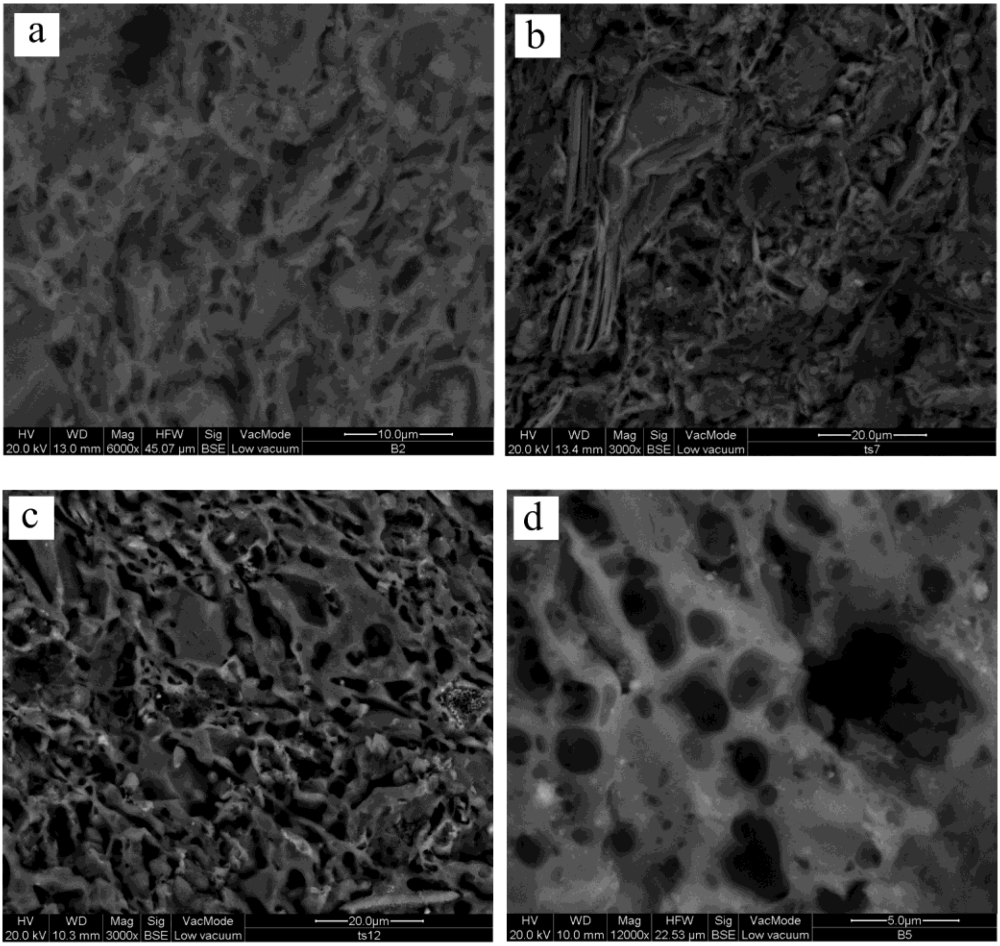

Fig. 4 - SEM micro-morphological analysis of the groundmass. Representative sherds - a) and b) group 1 samples: initial vitrification where the laminar habit of phyllosilicates is still preserved (b); c) and d) group 2 samples: extensive vitrification with bloating pores.

XRpD data on the clay samples show the marked homogeneity of the mineralogical composition in all specimens. Quartz is always the most abundant phase, followed by calcite, chlorite, micas and feldspar. Variable amounts of dolomite in all samples were also identified.

XRF analysis

The chemical composition of the ceramic fragments is strongly related to the source of clays and other materials used for its production. Moreover, the variations in the trace element concentrations reflect geological diversity (Hein *et al.*, 2004). The elemental concentrations of ceramics and sediments are given in Table 3.

The results were processed graphically and compared with chemical data of the sampled clayey materials, to better highlight possible chemical differences among the sherds.

tablE 2

XRPD data: results and range of firing temperatures (T°C) of the analysed ceramic samples.

Sample	*Qz*	*Pl*	*K-feld*	*Cc*	*Geh*	*Di*	*Hm*	*∑Phy*	*T°C*
ts1	x	x	x	nd	x	x	tr	nd	> 850
ts2	x	x	x	x	tr	nd	nd	tr	> 850
ts3	x	x	x	nd	nd	x	nd	x	> 850
ts4	x	x	x	nd	x	x	nd	tr	> 850
ts5	x	x	x	nd	x	x	nd	tr	> 850
ts6	x	x	x	tr	tr	x	tr	tr	> 850
ts7	x	x	x	x	tr	nd	tr	x	> 850
ts8	x	x	x	nd	x	x	tr	nd	> 850
ts9	x	x	x	nd	nd	x	nd	nd	> 850
ts10	x	x	x	nd	tr	x	tr	nd	> 850
ts11	x	x	x	nd	x	x	nd	nd	> 850
ts12	x	x	x	nd	x	x	tr	nd	> 850
ts13	x	x	x	nd	tr	x	tr	nd	> 850
ts14	x	x	x	x	x	tr	x	tr	> 850
b1	x	x	x	nd	nd	nd	x	tr	> 850
b2	x	x	x	tr	x	x	tr	x	> 850
b3	x	x	x	nd	nd	nd	x	tr	> 850
b4	x	x	x	nd	x	x	tr	tr	> 850
b5	x	x	x	tr	tr	nd	tr	nd	> 850
b6	x	x	x	x	x	nd	nd	nd	> 850

Qz - quartz; pl - plagioclase; K-feld - K-feldspar; Cc - calcite; geh - gehlenite; Di - diopside; Hm - hematite; ∑ phy - phyllosilicates; x - present; nd - not detected; tr - trace.

the al_2o_3 *vs*. Fe_2o_3 plot (Fig. 5a) shows two different groups of pottery. the first group consists of group 1 ceramics, that are quite similar to local clay samples of baragiano and tito area. the group 1 shows lower Fe_2o_3 (up to 5.66 %) and al_2o_3 (up to 15.07 %) contents compared to the "more fine" ceramics (group 2), characterized by higher Fe_2o_3 (6.25-8.92 %) and al_2o_3 (16.84-19.86%) values. the ts14 sample, associated to a colonial production on the basis of archaeological observations (osanna *et al*., 2008), shows the highest content of the above-mentioned two oxides. the clayey materials of the potenza quarry are characterized by the lowest values (Fig. 5a).

in the Sio_2 *vs*. Cao plot (Fig. 5b), the less fine ceramics (group 1) and the local clay samples are characterized by similar calcium values ranging from 7.99% to 11.94%. only the potenza clay samples show the highest Cao values (average = 12.91%). the more fine ceramics (group 2) are characterized by lower Cao contents (below 6.83%). in particular, the baragiano ceramics highlight the lowest Cao

Table 3

XRF data: Concentrations of major elements (wt%) and trace elements (ppm) of the studied samples.

	Torre di Satriano ceramic samples														Baragiano ceramic samples					
Sample no.	***ts14***	***ts13***	***ts12***	***ts11***	***ts10***	***ts9***	***ts8***	***ts7***	***ts6***	***ts5***	***ts4***	***ts3***	***ts2***	***ts1***	***b6***	***b5***	***b4***	***b3***	***b2***	***b1***
Oxides (wt%)																				
SiO_2	49.19	58.70	62.68	59.90	61.87	61.20	61.32	60.34	55.48	57.67	59.65	58.24	58.10	61.20	61.23	60.73	58.84	58.87	55.95	56.99
TiO_2	1.04	1.06	0.94	0.90	0.96	0.97	0.91	0.67	0.71	0.69	0.68	0.73	0.73	0.89	0.90	0.96	0.83	0.97	0.71	1.01
Al_2O_3	19.64	18.22	16.84	17.30	17.50	17.25	16.56	14.06	13.72	13.86	14.01	14.22	15.07	17.63	17.63	17.50	18.25	18.24	14.78	19.86
Fe_2O_3	8.92	7.23	6.79	6.51	6.87	7.01	6.49	4.99	5.49	5.49	5.27	5.22	5.30	6.34	6.84	7.68	6.25	6.81	5.57	7.15
MnO	0.18	0.13	0.12	0.11	0.12	0.12	0.12	0.08	0.11	0.10	0.11	0.13	0.10	0.09	0.11	0.11	0.10	0.07	0.13	0.05
MgO	5.22	3.40	3.14	3.24	3.02	3.26	3.09	3.13	3.96	3.85	3.31	3.58	3.39	2.85	3.33	3.12	3.82	2.72	3.06	2.54
CaO	7.87	6.57	5.24	6.69	5.12	5.81	6.83	7.99	11.94	10.92	9.12	11.59	9.34	5.68	3.66	4.44	4.31	3.31	10.88	1.55
Na_2O	0.66	0.76	0.76	0.63	0.74	0.67	0.68	0.99	1.04	1.10	0.97	1.03	0.82	0.70	0.73	0.79	1.09	0.60	0.60	0.35
K_2O	2.47	2.16	1.91	2.24	2.11	1.99	2.06	2.71	1.90	2.03	2.68	2.57	2.74	2.38	2.74	1.95	3.99	2.38	2.64	2.28
P_2O_5	0.23	0.26	0.18	0.22	0.21	0.20	0.20	0.25	0.69	0.48	0.43	0.36	0.38	0.20	0.25	0.47	0.23	0.25	0.81	0.30
LOI	4.47	1.30	1.12	1.84	1.10	1.00	0.93	3.30	4.10	3.12	3.02	1.88	3.12	1.10	2.01	2.01	1.70	4.58	4.10	6.70
Total	99.89	99.79	99.72	99.58	99.62	99.48	99.19	98.51	99.14	99.31	99.25	99.55	99.09	99.06	99.43	99.76	99.41	98.80	99.23	98.78
Trace elements (ppm)																				
Ni	92	78	75	64	73	74	65	52	117	106	59	57	49	67	76	77	62	75	73	103
Cr	169	173	160	153	163	173	153	101	168	155	107	108	86	143	153	176	131	158	124	192
V	136	188	167	174	168	194	175	107	142	144	125	147	119	170	173	194	146	147	146	181
La	57	42	32	28	38	36	26	27	27	42	36	20	25	30	38	26	51	31	25	21
Ce	103	86	88	79	86	84	79	69	63	64	66	67	66	86	95	90	96	87	71	97
Rb	97	105	100	111	105	101	102	123	131	126	122	117	120	122	129	97	197	122	113	116
Ba	476	239	238	307	248	222	309	390	493	420	466	320	376	320	420	297	654	339	490	479
Nb	21	21	20	19	21	20	19	17	14	14	16	15	16	19	20	21	22	22	15	24
Y	36	31	24	22	23	23	23	26	27	24	25	27	30	24	27	26	32	24	26	27
Sr	207	259	229	240	229	233	233	278	406	385	320	309	273	210	248	253	182	192	470	149
Zr	179	164	150	130	151	142	146	189	161	162	175	152	178	161	169	159	191	163	155	170

Table 3
... continued

	Potenza clay samples						Baragiano clay samples			Tito clay samples			
Sample no.	***pz6***	***pz5***	***pz4***	***pz3***	***pz2***	***pz1***	***bg3***	***bg2***	***bg1***	***ti4***	***ti3***	***ti2***	***ti1***
Oxides (wt%)													
SiO_2	52.01	51.53	52.52	51.04	52.53	52.18	52.19	52.27	52.60	50.24	50.23	50.63	50.10
TiO_2	0.55	0.54	0.55	0.56	0.53	0.55	0.64	0.62	0.63	0.67	0.67	0.65	0.68
Al_2O_3	11.05	11.27	11.13	11.53	10.88	11.06	13.08	12.62	12.78	13.34	13.21	13.05	13.21
Fe_2O_3	3.52	3.75	3.51	3.55	3.53	3.53	4.47	4.89	4.66	4.86	4.85	4.55	4.95
MnO	0.08	0.08	0.08	0.07	0.08	0.08	0.06	0.07	0.06	0.10	0.10	0.10	0.10
MgO	3.21	3.24	3.22	3.26	3.17	3.21	3.41	3.38	3.46	3.42	3.35	3.33	3.40
CaO	13.12	12.81	12.74	13.19	12.67	12.93	9.67	9.87	9.54	10.46	10.37	11.05	10.26
Na_2O	0.92	0.91	0.95	0.91	0.96	0.96	0.52	0.51	0.51	0.83	0.92	0.82	0.81
K_2O	2.02	2.06	2.03	2.02	2.00	2.03	2.36	2.28	2.29	2.38	2.39	2.28	2.39
P_2O_5	0.13	0.13	0.13	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
LOI	13.10	13.15	13.12	13.21	13.32	13.05	13.22	13.13	13.11	12.98	13.20	13.33	13.33
Total	99.71	99.47	99.98	99.48	99.80	99.71	99.75	99.77	99.77	99.41	99.42	99.92	99.36
Trace elements (ppm)													
Ni	40	45	36	42	39	42	45	48	48	53	52	62	54
Cr	61	71	68	70	70	63	96	93	96	104	96	105	97
V	95	104	96	105	98	96	130	126	125	138	127	139	138
La	14	9	8	8	8	17	8	15	31	27	27	31	25
Ce	47	49	45	42	42	43	59	62	56	65	54	63	62
Rb	91	93	91	90	91	91	114	110	112	109	106	110	111
Ba	238	239	237	240	237	244	341	300	324	273	272	264	277
Nb	13	13	13	11	12	12	15	14	15	15	15	15	15
Y	31	27	31	28	30	29	29	28	27	31	29	27	29
Sr	340	351	339	346	341	338	307	300	304	268	298	272	288
Zr	197	164	206	173	183	183	157	157	162	151	168	154	159

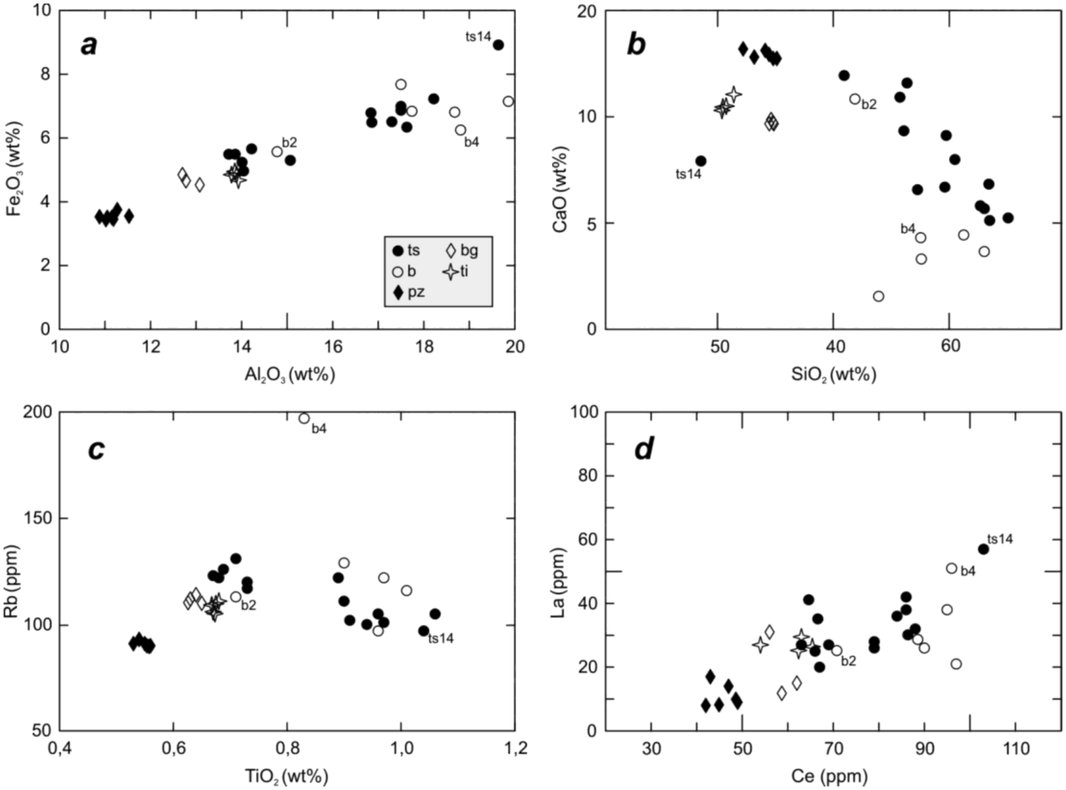

Fig. 5 - plots of some elemental concentrations in the studied ceramic samples and comparisons with local pliocene clayey sediments. (a) al_2o_3 *vs.* Fe_2O_3; (b) Sio_2 *vs.* Cao; (c) tio_2 *vs.* Rb; (d) Ce *vs.* la. 'ts' - torre di Satriano ceramic samples; 'b' - baragiano ceramic samples; 'pz' - potenza clay samples; 'bg' - baragiano clay samples; 'ti' - tito clay samples.

concentrations. Regarding Sio_2 percentages both ceramic group 1 and group 2, show higher contents (55.95% - 62.68%) than the clayey samples (50.10% - 52.60%). the ts14 sample (Fig. 5b) highlights a different behavior, since it is characterized by the lowest Sio_2 content (49.19%).

the tio_2 *vs.* Rb plot shows that the group 1 ceramics are well related to the local clay samples of baragiano and tito area (Fig. 5c); these samples are characterized by tio_2 values ranging from 0.62% to 0.73%. the group 2 ceramics shows higher tio_2 values ranging from 0.83% to 1.06%. only the b4 sample, associated to a colonial provenance on the basis of archaeological observations, shows the highest Rb content (197 ppm).

Furthermore, the Ce *vs.* la plot shows a relationship between group 1 ceramics and local clay samples of baragiano and tito area (Fig. 5d). the potenza clay samples are characterized by lower la and Ce values. the ts14 sample is *outlayer* since it is probably associated to a colonial provenance on the basis of archaeological observations.

Discussion

Torre di Satriano and Baragiano ceramics are characterized by similar petrographic features: a fine-fabric with few small aplastic inclusions. On the basis of grain sizes, two groups are distinguished, a “less fine” group 1 and a “more fine” group 2. This suggests that the employed raw clayey materials may have been subjected to different forms of depuration/levigation or to aplastic fraction addition, before production. XRPD mineralogical analyses and SEM morphological study suggest the firing temperature range based on the neoformed mineral phases (Capel *et al.*, 1985; Duminuco *et al.*, 1996; Riccardi *et al.*, 1999; Cultrone *et al.*, 2002), such as gehlenite, hematite and diopside. Most of the Torre di Satriano and the Baragiano findings, contain the above mentioned neo-formed phases (Table 2) suggesting firing temperature higher than 850°C as confirmed by the high degree of groundmass vitrification (Fig. 4c-d). Neo-formed phases are absent in the B1 and B3 Baragiano fragments since the employed raw materials are CaO-poor (Cultrone *et al.*, 2002), as displayed by XRF analysis.

The chemical similarity between the pottery of group 1 (less fine ceramics) and the sampled clays of Baragiano and Tito, might suggest the use of local clayey materials with a small selection and depuration treatment needed for processing. The coarser grain size of group 1 ceramics could be related to the aplastic fraction addition as also inferred by the higher SiO_2 values (Kilikoglou *et al.*, 1988).

Furthermore, the finest ceramics of group 2 (more fine ceramics) may have been locally produced following a greater selection and levigation of the clayey materials. This process may explain the smaller particle size observed in thin section and the higher Al_2O_3, Fe_2O_3, TiO_2 and several trace element contents (Fig. 5 and Table 3). However, the elemental content of the group 2 ceramics and the compositional gap between the two groups (Fig. 5) may be related to a different raw material source-area. The Lucanian Basin is indeed characterized by several fine-grained terrains (e.g. Cretaceous-Lower Miocene sediments), cropping out near the archaeological sites, with a chemical composition close to the group 2 ceramics (e.g. Mongelli *et al.*, 1996; Fiore *et al.*, 2000; Cavalcante *et al.*, 2003). Therefore future sampling and comparison with those fine-grained sediments are needed to verify these hypotheses.

The TS14 fragment could be excluded from local production since it show a different composition, corroborating the archaeological assumptions.

The B2 ceramic fragment follows the chemical variation of the group 1, even if the archaeological features suggest a different production area for this sample.

Conclusions

The analysed ceramic fragments found in the Baragiano and Torre di Satriano (PZ) archaeological sites, were attributed to local production on the basis of archaeological, petrographic, mineralogical and chemical evaluations.

Microscopically the ceramics fragments have very similar petrographic features for groundmass, microstructure and inclusions. Two groups are distinguished, a “more fine” group 1 and a “less fine” group 2, based on grain sizes and inclusion/matrix ratios.

XRPD mineralogical analyses and SEM morphological study suggest firing temperature higher than 850°C, as confirmed by the presence of neoformed mineral phases (gehlenite, hematite and diopside) and by the high degree of groundmass vitrification.

The comparison between the chemical composition of the ceramics and the clayey materials of the north Lucanian Basin, suggests the use of local pliocene clay with small depuration treatment and/or aplastic fraction addition for the Group 1 ceramics. The more fine ceramics of group 2 show different chemical variations that are not justified only by clay levigation processes but are probably related to other fine-grained sediments (e.g. Cretaceous-Lower Miocene terrains) cropping out around the archaeological sites. Those sediments, will be sampled and analysed to corroborate these hypotheses. in both cases, the presence of several production centers in the north-Lucanian area more and less in mutual contact, cannot be excluded.

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