Studia Universitatis Babeş-Bolyai, Geologia, 2009, **54** (2), 5 – 8

Contrasting recipes for the kiln furnitures of the faience manufacture Granges-le-Bourg (Haute Saône, France)

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Received February 2009; accepted June 2009
Available online September 2009

ABSTRACT. Thirty-nine samples of kiln furniture or technical ceramic (firing plate, saggars, spacers, props, wads) and six samples of building ceramics (bricks, tiles) from the manufacture of Granges-le-Bourg were studied by optical microscopy, X-ray fluorescence, X-ray diffraction and scanning electron microscopy. The kiln furniture is chemically inhomogeneous and belong to a CaO- + MgO-poor (firing plate, saggars) or a CaO- + MgO-rich (props, spacers, wads) group. Bricks and tiles pertain to the first group, which was manufactured using decarbonatized top layers of local Triassic dolomitic marls. For the second group, the deeper layers were used. Plate and saggars are covered with a tin oxide opacified glassy coating with no significant reaction zone to the body.

Key words: Granges-le-Bourg, kiln furniture, high-Mg faience, Triassic marl, dolomite.

INTRODUCTION

During archaeological excavations of the brickworks (16^{th} - 19^{th} c.) from Granges-le-Bourg, faience waste was found from an unknown late 18^{th}/early 19^{th} c. production (Morin and Morin-Hamon, 2004). In Granges-le-Bourg, coarse, as well as fine ceramic was therefore produced simultaneously. Results of the archaeometric analyses of the fine ware, i.e. the faience, and seven local clays have already been discussed (Maggetti et al., 2009). This study focus on 39 samples of kiln furniture or technical ceramic (firing plate, saggars, spacers, props, wads) and six samples of building ceramic (bricks, tiles) in order to answer the following questions: (1) Are there chemical differences between the technical, the building and the fine ceramics? (2) Did the potters use specific refractory clays and different recipes for the various ceramic types? (3) Are the raw materials of local or foreign (imported) origin?

Analytical techniques were optical microscopy, X-ray fluorescence (XRF), X-ray diffraction (XRD) and scanning electron microscopy (SEM), coupled to an energy-dispersive X-ray spectrometer (EDS). For analytical details see Maggetti et al. (2009).

TERMINOLOGY

Firing plates are also called shelves. Saggars are ceramic containers in which the tin-glazed earthenware is fired. Spacers or pegs support the pottery in the saggars while the columnar props support the firing plates. Wads have varying forms as their main function is to insulate the saggars from the fire, to separate and to stabilize the vessels in the kiln.

OPTICAL MICROSCOPY

Under the polarizing microscope, faiences, props, spacers and wads show fine-grained bodies with tiny quartzes (maximum diameter up to 140 µm) and Fe-concretions as non plastic inclusions (Fig. 1). The matrix of the firing plate and of the saggars doesn't differ, but both types contain well-rounded and well-sorted coarse grains of chert, microcline and mono/polycrystalline quartz (diameter 1 to 1.5 mm, Fig. 2), resulting in a hiatal distribution of the non plastic inclusions (Maggetti, 1994).

CHEMICAL COMPOSITION

Many samples show unusually high lead concentrations (Table 1). The causes of this Pb-contamination were discussed by Maggetti et al. (2009). The kiln furnitures have different chemical compositions, as evidenced by the XRF analyses. The firing plate, the saggars and the building ceramics are - with the exception of GLB 6 - calcium- and magnesium-poor (Fig. 3), well suited to support high firing temperatures as well as several firing cycles. Contrasting,

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props, spacers and wads show markedly higher CaO and MgO. This is corroborated by a principal component analysis (PCA) considering together major, minor and trace elements of the faiences, the clays and the kiln furnitures. Three distinct groups can be recognized (Fig. 4): (1) Bricks, firing plate, saggars and tiles; (2) Props, spacers and wads; (3) Faiences. Ca- and Mg-poor clays have comparable chemical compositions as the props. Three very Ca+Mg-rich clays are set apart.

It is interesting to note that one clay as well as some props and all spacers match the chemical composition of the faiences for mostly all oxides.

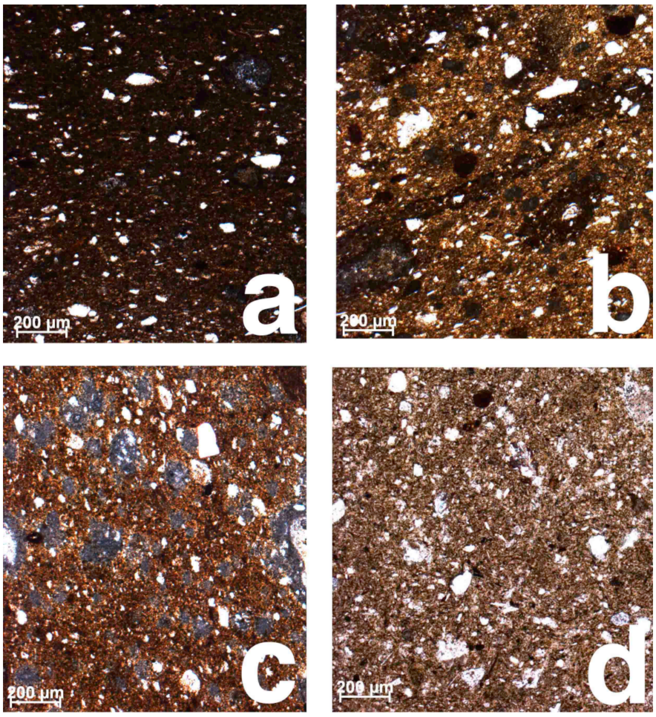

Fig. 1. *Microphotographs of thin sections of a faience (a; GLB 28), a prop (b; GLB 99), a spacer (c; GLB 32) and a wad (d; GLB 51). Parallel polarizers.*

RAW MATERIALS

The brick & tile and faience works of Granges-le-Bourg are located on dolomitic, gypsiferous marls of the Triassic Middle Muschelkalk (Middle Anisian), see Contini (2000) and Contini et al. (2000). As shown by XRD, these clays are rich in dolomite (up to 50 wt. %). In profiles, both MgO and CaO decrease from deeper layers upward, the concentrations of these two oxydes being very low close to the surface. Such features indicate progressive leaching of the mineral dolomite. Red Triassic sandstones (Buntsandstein) crop out close to the manufacture and were used for the construction of the kilns. These sandstones show rounded quartzes. By decaying, very pure quartz sands are generated.

GLAZES

The firing plate and some saggars are internally coated with a tin opacified lead glaze, which is markedly thinner and richer in splintery quartzes than the corresponding glaze of the faiences. Area measurements (60 x 50 µm) by SEM EDS showed a mean SnO_2 content of 9.1 wt. % for the faiences and 5.2 wt. % for the kiln furnitures. No reaction zone between the body and the glaze could be observed.

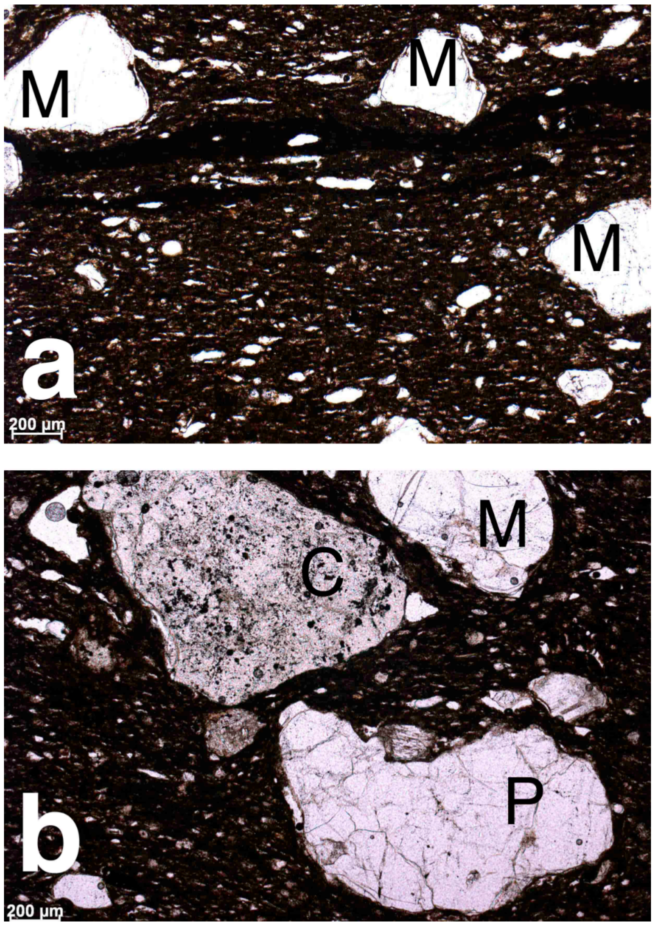

Fig. 2. *Microphotographs of thin sections of a firing plate (a; GLB 107) and a saggar (b; GLB 91), showing rounded grains of chert (C) and mono- (M) as well as polycrystalline (P) quartzes in a fine grained, non-calcareous matrix. Parallel polarizers.*

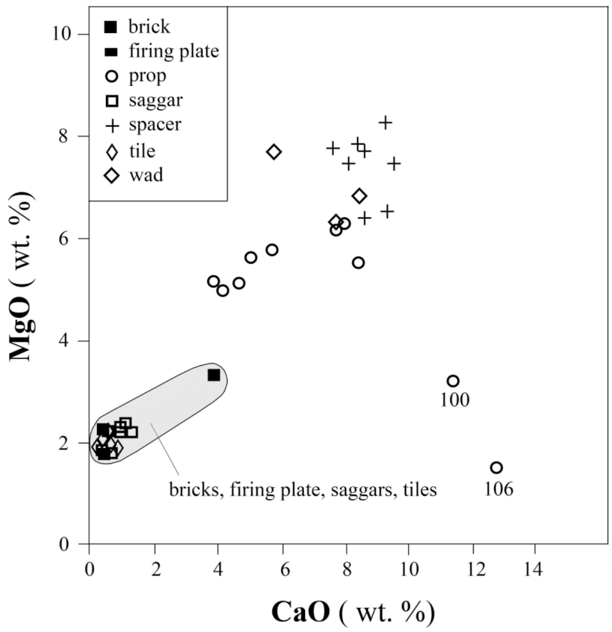

Fig. 3. *MgO - CaO correlation diagram.*

An. no.		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ba	Cr	Cu	Nb	Ni	Pb	Rb	Sr	Y	Zn	Zr	Sum
GLB5	B	66.71	0.88	17.13	6.13	0.19	1.74	0.41	1.12	4.98	0.12	497	107	38	17	42	365	216	144	28	251	282	99.63
GLB6	B	61.37	0.89	18.46	5.98	0.12	3.31	3.86	1.14	5.32	0.12	563	92	41	17	45	108	244	172	27	117	217	100.75
GLB17	B	64.12	0.94	18.91	5.95	0.11	2.22	0.43	1.06	5.64	0.09	653	98	48	18	55	60	250	135	30	116	231	99.66
GLB3	T	64.91	0.92	18.20	5.98	0.07	1.89	0.31	1.03	5.41	0.10	438	97	21	18	40	30	247	148	32	90	267	99.00
GLB4	T	63.86	0.93	19.12	6.71	0.15	2.02	0.42	1.16	5.30	0.12	344	89	46	18	51	73	237	173	29	111	241	99.96
GLB119	T	67.35	0.90	16.72	5.84	0.17	1.97	0.66	0.78	4.78	0.15	502	81	49	18	44	118	207	137	43	129	317	99.51
GLB107	F	65.42	0.83	17.04	5.48	0.10	2.20	1.09	0.65	4.87	0.15	547	86	41	17	43	7247	205	142	54	142	242	98.72
GLB79	P	54.29	0.76	17.42	6.72	0.15	6.26	7.93	1.32	5.09	0.21	591	100	46	15	43	1320	170	182	25	86	167	100.43
GLB98	P	58.72	0.74	16.41	5.83	0.09	5.75	5.74	0.55	5.06	0.20	541	97	194	13	45	3271	186	153	40	119	192	99.59
GLB99	P	54.62	0.76	17.49	6.57	0.10	5.50	8.43	0.58	5.11	0.20	498	87	30	17	49	602	187	179	32	92	177	99.55
GLB100	P	60.95	0.70	14.02	5.72	0.13	3.19	11.44	0.79	2.56	0.16	327	141	37	17	87	28	125	332	37	103	231	99.81
GLB101	P	60.50	0.78	17.31	5.38	0.09	5.12	3.94	0.51	5.38	0.20	470	92	108	18	43	2241	201	159	40	108	207	99.59
GLB102	P	60.02	0.76	16.52	5.75	0.10	5.07	4.66	0.49	4.95	0.21	505	97	162	16	45	3885	190	156	41	135	207	99.08
GLB103	P	60.45	0.78	17.03	5.18	0.09	4.95	4.18	0.55	5.31	0.18	465	102	160	21	42	3798	197	170	44	108	232	99.25
GLB104	P	54.10	0.75	17.31	6.53	0.10	6.19	7.77	0.70	5.10	0.21	479	106	36	18	48	2830	184	199	36	96	180	99.19
GLB106	P	60.63	0.83	14.69	4.85	0.04	1.51	12.79	0.42	3.34	0.12	262	118	17	20	54	2749	132	152	57	69	241	99.62
GLB115	P	58.46	0.77	17.21	6.32	0.11	5.60	5.04	0.56	4.90	0.25	588	107	33	17	46	295	193	155	35	123	184	99.42
GLB19	Sa	67.28	0.88	16.36	5.74	0.18	1.74	0.47	1.19	4.59	0.14	546	77	35	17	40	6563	198	142	35	208	300	99.42
GLB20	Sa	67.09	0.83	16.59	5.42	0.11	2.17	1.14	1.12	4.62	0.16	571	78	48	17	39	4223	211	162	30	158	241	99.83
GLB21	Sa	67.12	0.83	16.48	5.47	0.13	2.16	1.04	1.15	4.56	0.15	502	81	52	18	41	4599	208	155	32	165	241	99.71
GLB22	Sa	64.44	0.90	18.99	6.40	0.16	2.21	0.55	1.11	5.17	0.14	522	96	47	18	49	61	236	155	31	120	253	100.25
GLB78	Sa	67.63	0.84	16.89	5.36	0.09	2.13	0.99	1.26	4.81	0.14	540	72	53	17	35	1643	197	159	29	167	228	100.48
GLB89	Sa	65.20	0.81	18.34	4.80	0.06	2.10	0.92	0.55	5.59	0.22	660	91	159	16	40	3069	231	178	32	116	212	99.07
GLB90	Sa	67.36	0.83	16.61	5.26	0.10	2.34	1.07	0.62	4.59	0.17	558	80	42	17	36	504	199	156	30	160	223	99.18
GLB91	Sa	64.62	0.89	18.68	5.87	0.08	2.19	0.90	0.91	5.34	0.19	741	62	145	15	29	890	205	354	34	122	220	99.98
GLB92	Sa	69.06	0.86	16.10	4.97	0.11	1.77	0.69	1.11	4.81	0.18	671	80	72	18	34	1722	196	164	32	124	326	98.30
GLB93	Sa	67.16	0.86	16.62	5.81	0.16	2.01	0.54	0.75	4.72	0.18	621	85	35	17	36	148	195	135	32	127	264	99.01
GLB23	Sp	55.01	0.71	16.04	6.15	0.10	6.50	9.35	1.13	4.27	0.18	624	92	51	14	44	205	160	149	20	101	162	99.64
GLB24	Sp	52.36	0.74	17.13	6.66	0.10	6.62	7.06	2.18	4.88	0.20	320	74	58	17	47	18320	166	164	39	92	178	99.91
GLB30	Sp	52.72	0.73	16.78	6.47	0.10	7.48	9.57	1.00	4.58	0.18	671	66	36	16	45	179	163	187	19	85	148	99.78
GLB32	Sp	51.97	0.69	15.83	5.90	0.09	8.25	9.30	1.91	3.98	0.17	501	70	62	14	48	11880	161	142	31	113	167	99.43
GLB33	Sp	52.72	0.73	16.61	6.34	0.10	7.71	8.62	1.73	5.01	0.20	683	64	42	16	46	2027	184	184	21	85	157	100.15
GLB34	Sp	51.85	0.73	16.59	6.42	0.10	7.44	8.15	1.88	4.96	0.19	480	82	48	16	49	14850	162	173	35	84	170	99.94
GLB37	Sp	51.91	0.66	15.55	5.77	0.08	7.83	8.40	1.43	4.65	0.01	705	82	140	15	49	27127	113	109	46	93	195	99.16
GLB38	Sp	54.68	0.71	16.44	6.44	0.10	6.38	8.62	1.34	4.75	0.26	726	96	33	14	49	175	168	140	20	103	155	99.91
GLB88	Sp	53.15	0.74	16.94	6.30	0.10	7.76	7.63	1.28	5.14	0.26	603	86	81	15	45	8453	154	152	33	99	165	100.30
GLB51	W	55.50	0.76	17.13	6.58	0.10	7.68	5.74	1.44	4.63	0.17	645	86	34	17	46	1016	168	108	21	90	167	99.98
GLB105	W	54.34	0.73	16.85	6.39	0.10	6.85	8.49	0.84	4.70	0.20	495	87	31	17	47	710	162	161	33	96	170	99.70
GLB116	W	54.53	0.75	17.34	6.55	0.10	6.31	7.76	0.54	5.07	0.20	575	92	24	13	47	1001	181	173	34	90	176	99.40

Table 1. *XRF analyses of the kiln furnitures from the faience workshop of Granges-le-Bourg. Oxydes and sum in wt.%, elements in ppm.*
Fe_2O_3 = total Fe as Fe_2O_3. B = brick, T = tile, F = firing plate, P = prop, Sa = saggar, Sp = spacer, W = wad.

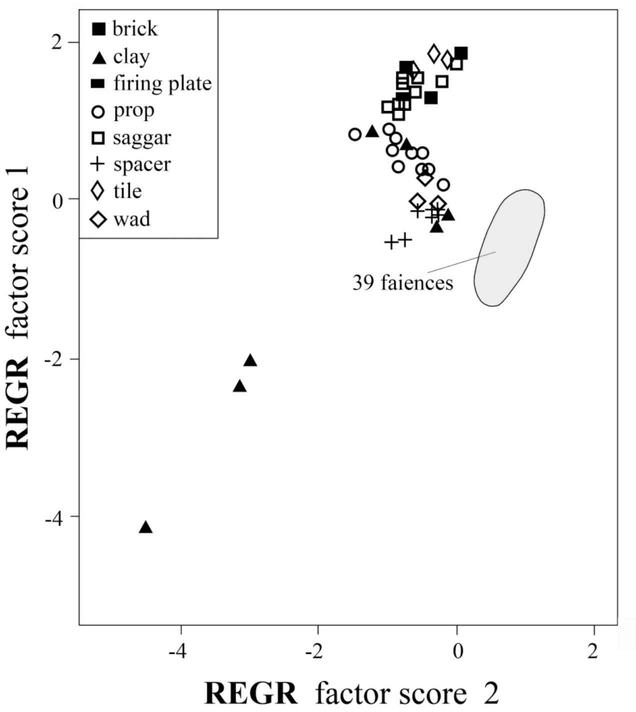

Fig. 4. *PCA plot. Compositions of faiences and clays from Maggetti et al. (2009).*

DISCUSSIONS AND CONCLUSIONS

The kiln furniture is chemically inhomogeneous and belong to two groups. The firing plate and all saggars are, like the locally made brick and tiles, CaO- and MgO-poor. Props, spacers and wads pertain to a second, CaO- and MgO-rich group and match partially the faience's composition.

The ancient potters obviously used two major recipes: *the firing plate & saggar* (= brick & tile) and the *prop & space* recipe. The use of a non-refractory clay for the props and spacers is puzzling. Ceramic objects with such high fluxes will melt around 1100°C and are therefore not very well suited to resist the firing temperatures of a furnace kiln, or to support many firing cycles. The potters used local raw materials and not imported, specific Al-rich, refractory clays. For the firing plate and the saggars, decarbonatized top layers of local dolomitic Triassic marls were chosen and mixed with local quartz sands.All spacers, props and wads were made using local dolomitic marls, which were probably not as well processed as the faience paste. A tin opacified glassy coating has been applied on the interior of the firing plate and some saggars. For obvious financial reasons, the potters used significantly less tin oxide, added much more crushed quartz and applied the watery glaze suspension with a much thinner stroke as for the faience. The absence of any significant reaction zone indicates that the glaze suspension was applied on already fired (biscuit fired) plates and saggars.

REFERENCES

Contini, D. 2000, *Notice explicative de la feuille Lure à 1/50'000e.* Éditions du BRGM, Service géologique national, Paris.

Contini, D., Creuzot, J., Dressler, M. & Théobald, N. 2000, *Carte géologique de la France à 1/50'000e feuille 443, Lure*. 2nd ed. BRGM, Service géologique national, Paris.

Maggetti, M. 1994, Mineralogical and petrographical metods for the study of ancient pottery. In *Proceedings of the 1st European workshop on archaeological ceramics*, 1991 (Burragato, F., Grubessi, O. & Lazzarini, L., Eds.), Università degli Studi La Sapienza, Roma, p. 23-35.

Maggetti, M., Morin, D. & Serneels, V. 2009, High-Mg faiences from Granges-le-Bourg (Haute Saône, France). In *Proceedings of the European Meeting on Ancient Ceramics* (EMAC'07) Vessels: inside and outside (Biró, T., Ed.), Hungarian National Museum, Budapest, *in print*.

Morin, D., Morin-Hamon, H. 2004, La tuilerie-faïencerie de Granges-le-Bourg. *Bulletin de la Société d'Histoire et d'Archéologie de l'Arrondissement de Lure (SHAARL)*, 23: 94-104.