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Autor: Maggetti, Marino / Valfré, Patrice

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Enigmatic « William Tell » decorations printed on French white earthenware (faïence fine) plates: some archaeometric and historic answers

Marino Maggetti[1] & Patrice Valfré[2]
[1]Department of Geosciences, University of Fribourg, CH-1700 Fribourg (Switzerland)
[2]Independent Researcher, Moulin de Portonville, 169, Route de Glandelles, F-77167 Bagneaux-sur-Loing (France)

« William Tell » decorations on French white earthenware (« faïence fine ») were very popular at the beginning of the 19th century. However, their origin is not clear. Do they come from the short lived (1791-1796) « Les Pâquis » factory in Geneva, a factory that moved 1796 to Eastern France (« Geneva-La Balme ») or from the Aumale factory in Northern France, circa 1830? The arguments for and against these possibilities are presented in some details. In order to move forward on this issue, one of these plates was examined chemically (X-ray fluorescence), mineralogically (X-ray diffraction), microscopically (Scanning electron microscope) and microchemically (Scanning electron microscope energy dispersive spectroscopy). The results were compared with those of two simultaneously analyzed plates. One of them belongs to the Montereau manufactory thanks to impressed mark, while the other has been attributed to the Aumale factory because of its decoration. The three plates classify as Al-rich and Ca-poor white earthenwares. Their ceramic bodies were made from an artificial mixture of highly plastic Al-rich clay and calcined, ground flint and quartz temper. But they differ in their chemical and mineralogical composition, as well as in their microstructure. The plate in question with a « William Tell » decoration differs from the other two in several aspects, such as: (1) The XRD spectrum lacks cristobalite and mullite, which suggests firing temperatures of max. 950 °C *(over* 1050 °C *for both others). This goes well with its higher loss on ignition; (2) The glaze differs from the other two in its higher maximum thickness of* 66 µm *versus* 45 µm. *Both others are virtually inclusion-free, apart from a few quartz relics, while the plate in question contains abundant arsenic-rich microcrystallites; (3) In the black trans-*

fer print decoration primary colour pigments in the form of ground grains of types I (Fe), II (Cu bearing Mn), III (Fe, Mn) and IV (Ba-bearing Mn) can be observed. All types are lined with small kentrolite-melanotekite crystals, which were formed during the glaze firing, most likely in the cooling phase. This typology is also found in the Montereau plate, whereas type IV is missing in the one attributed to Aumale; (4) There are also clear differences with the published plate analyses from the manufactories of Bordeaux, Creil and Sarreguemines. In summary, the three plates reflect different technical processes respectively three different recipes. This could indicate an origin from three different manufactories or different technologies in the same manufactory. The lack of agreement with the recorded recipes from « Les Pâquis » and the composition of the plate assigned to Aumale can be seen as arguments that the « William Tell » plate does not come from these factories. On the other hand, an origin from « Geneva-La Balme » cannot be answered positively or negatively since there are no archival recipes known, nor analyses of plates from this manufacture published. A larger number of comparative analyses is needed to answer this question.

English and French white earthenware in the 18th and 19th centuries

White earthenware is a particular class of ceramics with a white, porous body and normally covered with a lead glaze. Such objects were manufactured for instance in France in the 16th century, as the so-called Saint-Porchaire » ware, a technologically outstanding Renaissance ceramic type, created during a brief period in the mid-sixteenth century [CR97], or the extra white pastes produced by Bernard Palissy (1510?-1590) in his Paris workshop in the years 1567-1586 [MU49, DU87]. Only the well-heeled could afford these expensive objects. In the first decades of the 18th century, new and much cheaper bodies were invented roughly contemporaneously in England and France [MAI08]. English potters preferred CaO-poor clays, abundant in their country, to create new ceramic types, but French potters used both CaO-poor and CaO-rich white firing raw materials (see below). In both kingdoms, production was soon on an industrial scale, so the objects could be named white-bodied industrial earthenware ».

Simple English, confusing French nomenclature

A summary introduction to the nomenclature, historical production techniques and archaeometry of this new ceramic genre was recently given [HE14, 255-278] [MA17]. White earthenware of the 18th century was typically called « creamware » or « Queensware » in England. In France, however, the nomenclature is extremely confused [PE03, MAI08, MA11, MA15]. In the 18th century many names were in use, such as « blanc fin », « cailloutage », « demi-porcelaine », « faïence blanche », « faïence boracique », « faïence feldspathique », « granit », « porcelaine anglaise », « porcelaine contrefaite », « porcelaine opaque », « terre d'Angleterre », « terre de fer », « terre de pipe », etc. [PE02, 9] [PE07] [MAG17, 159]. Evidently, these notions have a commercial, historical or art history connotation, all of which are currently outdated. From a technological point of view, they are even contradictory. Example: a porcelain body is by definition translucent, but that of a porcelaine opaque » [opaque porcelain] not. Nowadays the terms « faïence fine » or « terre de pipe » seem to be used mostly. However, the use of the term « faïence fine » [fine faïence] reflects neither the historical nor technological context. In the 18th century, it designated in France a luxury variant of the faïences communes » [common faïences], what was forgotten later [PE02, PE03]. And as far as the technological aspect is concerned, French « faïences » are covered with a white glaze, opacified by the presence of cassiterite (SnO_2) crystals, unlike white earthenwares which have a transparent glaze (with a few exceptions: [MA11, BL21]). In view of this complex nomenclatural problem, a neutral, purely descriptive term such as « terre blanche » [white earthenware] is better, as has already been suggested previously [PE02, PE03].

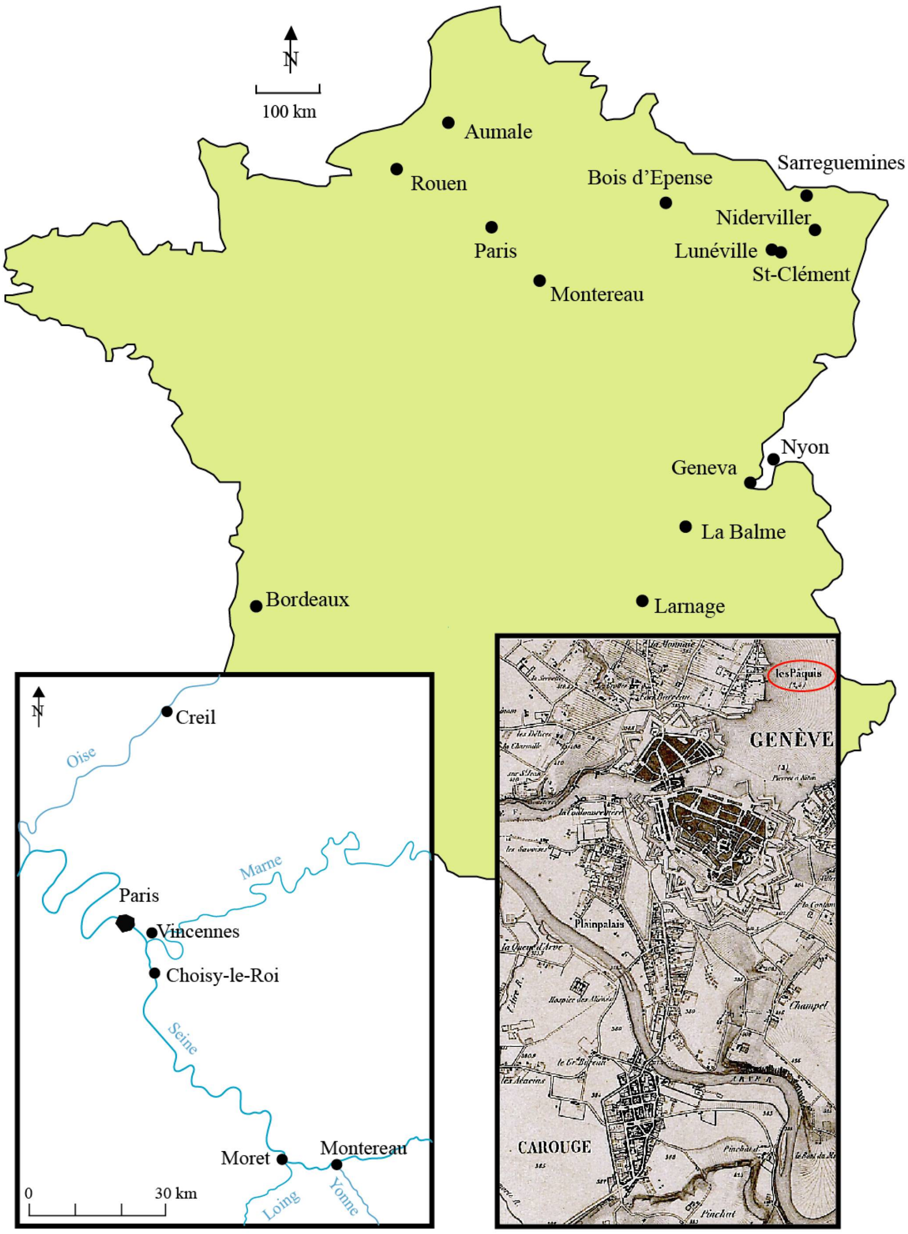

Figure 9.1: *Map of France with the places mentioned in the text. Left inlet: Closer view of the area around Paris. Right inlet: Location of Geneva, Carouge and Les Pâquis. Extract from the « Carte topographique du Canton de Genève »* 1 : 25′000, *sheet IV, published 1838.* © *Bibliothèque de Genève (*`oai:doc.rero.ch:20141002112801-ZZ`*). Drawing* Marino Maggetti.

Two successful French white earthenware manufactories in the 18th century with contrasting technical strategies

French white earthenware originated during the years 1730-1750 in Central (Paris) and Eastern (Lorraine) France [MAI08], see figure 9.1. These first French white earthenware manufacturers surprisingly used two different production techniques. In the capital Paris, the trigger for the production of white earthenware was linked to the porcelain production there. There, the « Rue de Charenton/Pont-aux-Choux » factory relied on local plastic clays with high Al and Si contents. Outside the capital and without any connection to the porcelain sector, other ways were to be found to create white earthenware. This was achieved in Lunéville with a novel mixture of imported high plastic clays, chalk and local quartz and Pb frits. These early manufactories will now be shortly presented.

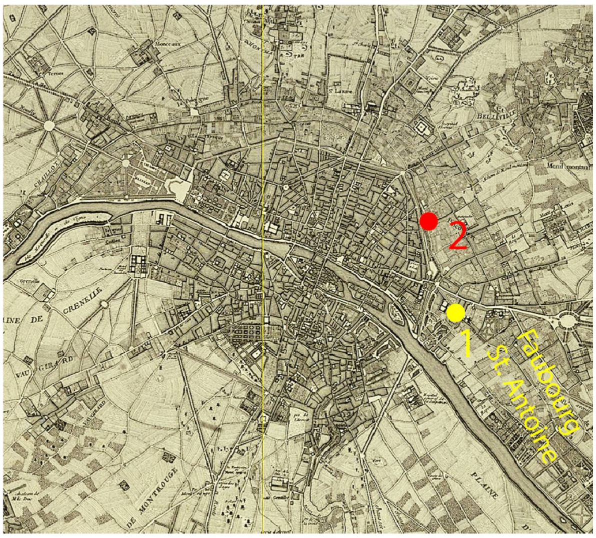

Figure 9.2: *City map of Paris (Delagrive 1744) with the « Faubourg Saint Antoine » and both locations of the manufactory. (1) « Rue de Charenton » (1743–1749), (2) «Pont-aux-Choux» (1749–1788). The vertical yellow line marks the meridian of Paris. © Bibliothèque nationale de France. Graphic design* MARINO MAGGETTI.

In the French capital, the Royal manufacture « de la fayance a l'imitation de celle d'angleterre » [of faïence imitating that of England] [MAI08, 84] was established by CLAUDE-IMBERT GÉRIN (1705-1750) in the year 1743 at the « Rue de Charenton » (Suburb « Saint Antoine ») and transferred in 1749 to a larger place near the bridge and the city gate « Pont-aux-Choux » [HO67, LE93, DE95, DE03, MA24]. Figure 9.2 shows both locations on an old city map of Paris [MA24, Fig.1]. The factory produced a pottery « dont la composition se fait avec une terre différente de celle qui s'employe dans la fayance ordinaire » [the composition of which is made with a clay different from the one used to make ordinary faïence] [DE95, 58]. At that time, « fayance ordinaire » was a tin-glazed earthenware made with red-firing iron-rich clays. GÉRIN created the new white earthenware body probably in the years between 1740 and 1743 when working at Vincennes to compose good recipes for crucibles in which glazes could be melted [DA84]. According to JEAN HELLOT (1685-1766), the primary chemist of the Sèvres manufactory [GR68], the new paste was made of 66% unfired and 33% calcined noncalcareous Moret clay [PR91, 18] [DE95, 60]. In the vicinity of Moret there are rich deposits of plastic clays, which are the oldest sediments of the Eocene (Ypresian) of the Paris Basin [MA24, 182-183]. They occur along the banks of the river Seine and its tributaries, as shown, for example, by the section of the area around Moret (Fig. 9.3; [MA24, Fig.11]). Mineralogically, the clays consist mostly of kaolinite and quartz. Anatase, rutile, calcite, chlorite, illite, smectite, gypsum, goethite, hematite, pyrite etc. occur as accessory minerals. The chemical analyses show that these white-firing plastic clays of the Paris basin are rich in aluminium (Al, expressed as oxide Al_2O_3) and silicium (Si, SiO_2). The calcium (Ca, CaO) content is less than 1 wt.% [TH82] [MA24, Tab.1]. Chemical analyses of objects believed to have been made in this manufactory include four fragments of the Royal busts of King LOUIS XV and his wife MARIA LESZCZYŃSKA (Fig. 9.4 & 9.5), which were destroyed in the Lunéville castle fire on January 2, 2003 [MO05]. Their affiliation was justified with historical arguments [MAI21, 56-57]. The busts are rich in aluminium and silicium, with very little calcium (Table 10.13). They fit well with the chemical composition of the highly plastic Ypresian clays. Five younger (ca. 1750-1788, [MA24, note 26]) plates (Fig. 9.6), with a «grain de riz » decor typical for the « Rue de Charenton/Pont-aux-Choux » factory [MAI08, 113], show slightly different chemical compositions (Tab. 10.13, TBL samples), but belong also to the High-Al and High-Si ceramic bodies. The chemical analyses show that earlier (busts) and later (plates) products differ chemically (Fig. 9.7). The busts have more titanium oxide TiO_2 (Fig. 9.7b), but fewer aluminium oxide Al_2O_3 (Fig. 9.7a), chromium Cr and nickel Ni (Fig. 9.7c), sodium oxide Na_2O and barium Ba (Fig. 9.7d) as the plates. Further, the microstructures are also different, because the plates show angular chamotte additions that are missing in the busts [MA24]. The transparent lead glazes also show chemical differences (Tab. 10.14). For example, the busts are richer in SiO_2 and K_2O, but lower in lead (Pb). A temporal evolution of the recipe can therefore be assumed.

In Lorraine, Jacques II Chambrette produced in the town of Lunéville (Fig. 9.1) a white earthenware, called « terre de pipe » (Fig. 9.8), perhaps as early as 1731 [PE07]. His success triggered the creation of 23 manufactories in Lorraine during the 18th century [PE07, MAI08]. Their white earthenwares were generally made up of four main ingredients: (1) Al_2O_3-rich refractory clay, (2) chalk, (3) Pb-frit, and (4) calcined flint or quartz pebbles [MA11]. The plastic clays came not from the Paris region, but most probably from the Westerwald, a region south of Cologne and the chalk from Champagne. Thanks to the addition of chalk, this synthetic mixture resulted in a CaO-rich ceramic body (Fig. 9.7a).

Not only in Lorraine, but also in other places too, new ways of produc-

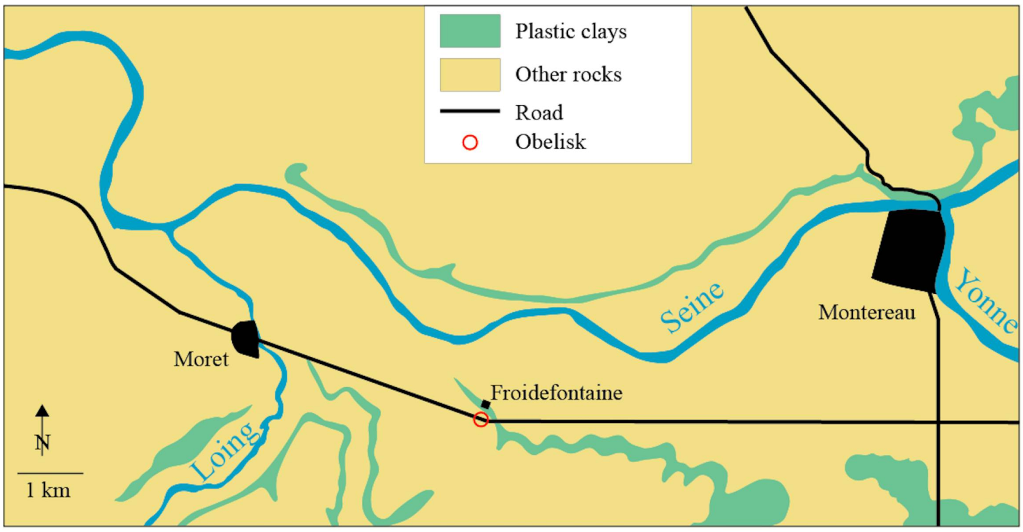

Figure 9.3: *Simplified geological map of the region between Montereau and Moret. Drawing MARINO MAGGETTI.*

ing white-firing dishes were eagerly sought in the second quarter of the 18th century. Shards from the very first known attempts for the manufacture of pitchers in white earthenware or white, fine-grained stoneware, fired at low temperatures, were found in the greater Paris region at Montereau (Fig. 9.1) in a potter's waste attributable to the JEAN ROGNON factory (circa 1720-1725). They can be considered as the prototypes that inspired ÉTIENNE FRANÇOIS MAZOIS for his subsequent productions of fine white earthenware or stoneware from 1749 [VA16b, 43]. In Rouen, PIERRE-PAUL CAUSSY (1693 - c. 1762; [SO12, 47]) was the first French potter to discuss the difficulty of producing white earthenware in his manuscript (c. 1735-1747; [LE04, 23-104] [DE07, 57]). In his experiments carried out around 1736-1737 [DE07, 26], he used in six experiments three ingredients (white-burning H-Al and H-Si clay, unfritted or fritted flint and a glass frit) as well as additional chalk in a seventh experiment [MA22, 40-41]. The experiments were obviously not satisfactory, because apart from a milk jug attributed to him (Fig. 9.9), no other white earthenware object is known from his manufactory.

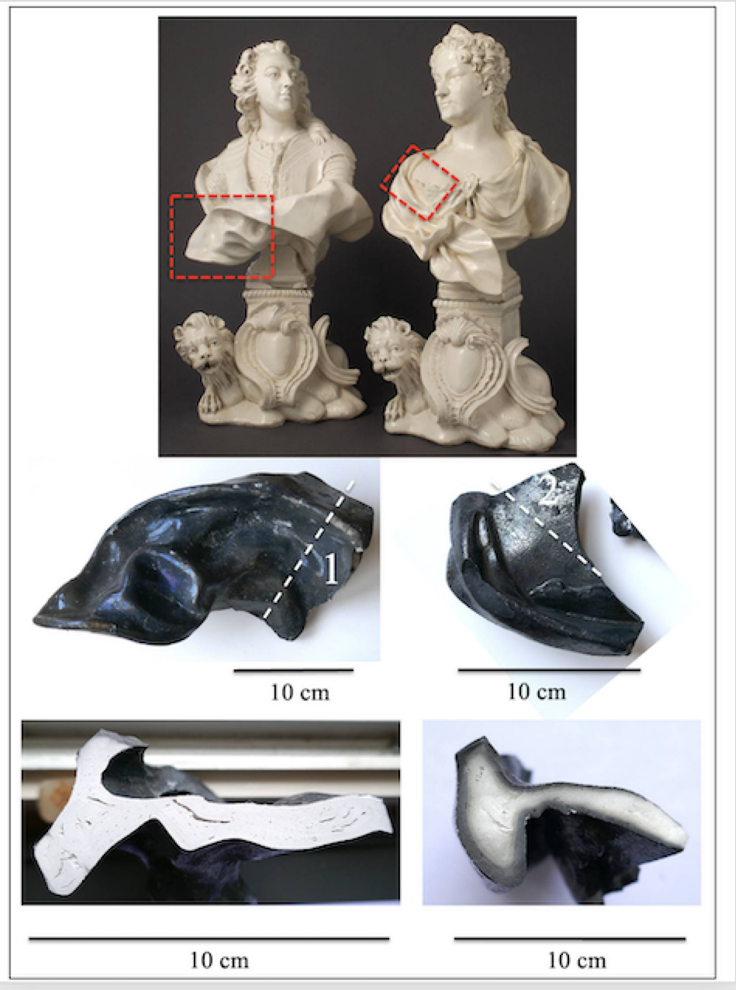

Figure 9.4: *Photo above: Busts of LOUIS XV (Versailles, 1710 – 1774) and MARIA LESZCZYŃSKA (Trzebnica, 1703 – Versailles 1768), on a base decorated with a lion. Attributed to the « Rue de Charenton/Pont-aux-Choux » factory. 1749-1755 (?). White earthenware. H: (Louis XV) 46 cm, (Queen) 53 cm. Sèvres, Manufacture and National Museum. Inventory number MNC3042 & MNC 4017. Photo (©) RMN-Grand Palais (Sèvres - National Manufacture and Museum) / MARTINE BECK-COPPOLA. Red stippled squares: original location of two superficially blackened fragments of similar busts destroyed by the Lunéville castle fire 2003 (Photos in the middle). The cuts to obtain samples BUS 1 and BUS 2 are shown with a dashed white line. Photos below: Cross sections of samples BUS 1 (left) and BUS 2 (right) without or with visible black coloration of the originally white earthenware bodies. Photos and graphic work* MARINO MAGGETTI.

Further attempts from 1755-1756 were reported by Mouchard, another potter in Rouen [MAI08, 93]: « Mouchard manufacturier de fayance au faubourg St sever de rouen a fait en 1755 et 1756 quelques gobelets de terre blanche assés légers et blancs mais vernis d'une couverte » [Mouchard fayance manufacturer in the suburb St Sever of Rouen made in 1755 and 1756 some white earthenware cups which were quite light and white but varnished with a glaze]. Mouchard also does not seem to have progressed beyond the experimental stages, as no white earthenwares have survived.

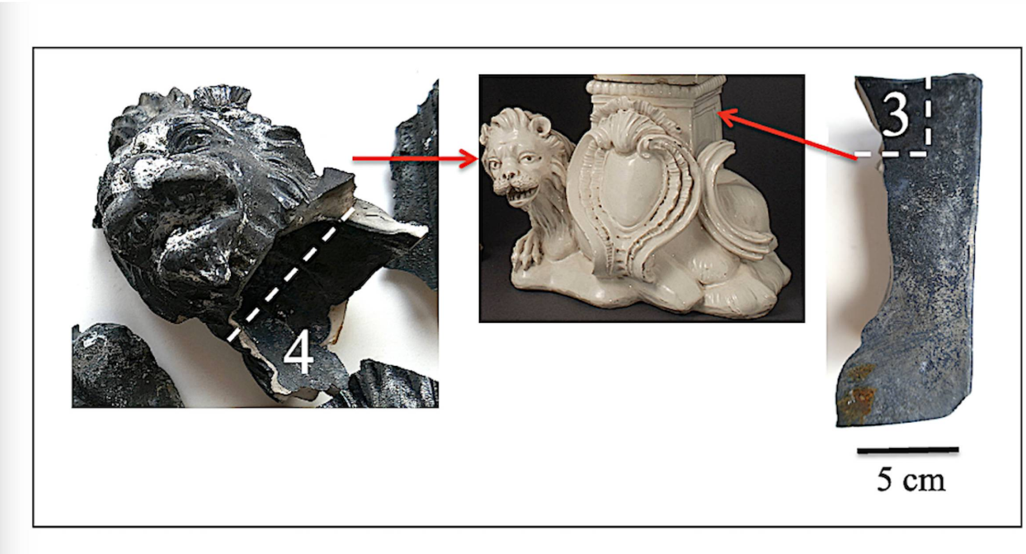

Figure 9.5: *Same informations as in figure 9.4 for samples BUS 3 and BUS 4.*

Evolution of the French white earthenware bodies

In France, white earthenware production reached rapidly industrial dimensions at the end of the 18th century, and persisted during the 19th century, with locations close to Paris such as Creil and Montereau. In the historical evolution of French white earthenware, three periods are to be distinguished [MAI08] : (1) 1743–1790: the coexistence of Al_2O_3- and SiO_2-rich (CaO-poor) bodies with CaO-rich bodies, (2) 1790–1830: the improvement of the H-Al and H-Si bodies by adding calcined flint or quartz pebbles to the paste, resulting in the so-called «cailloutage» type white earthenware, and (3) after 1830: a further improvement of these bodies by admixing kaolinite and feldspar to the paste. The successful story was not only limited to French territory. In the late 18th and early 19th centuries, many white earthenware factories blossomed in the neighboring countries such as Germany, Italy and Switzerland.

Figure 9.6: *(a) Gravy (meat juice) pot with cover. Molded decoration with « rice grain» or « barley corn » patterns. Attributed to the « Rue de Charenton/Pont-aux-Choux » pottery factory. White earthenware. C. 1760–1780. Reg. No. C.127&A-1945. © VICTORIA AND ALBERT MUSEUM, London. (b) Three fragments of one of the five plates analyzed (An. No. TBL 30) and destroyed by the Lunéville castle fire 2003. Same moulded decoration and attribution as (a). White earthenware. C. 1750-1758. H: 12 cm, L: 9,5 cm. Photo* Marino Maggetti.

Too few archaeometric analyses of French white earthenwares

The case of the Parisian manufactory «Rue de Charenton/Pont-aux-Choux» has been discussed (see above). Apart from this specific case, and apart from the impressive cohort of 150 examined samples from the Bordeaux LAHENS & RATEAU-JOHNSTON-VEILLARD manufactories [BE21], only 25 other white earthenware in the rest of France have so far been recently analyzed (Tab. 10.15). The analytical results [MA10, MA11, MA12, MA14] of eleven white earthenware figurines attributed to CYFFLE's

Lunéville manufactory (1768-1780) are not included in this list. The objects in table 10.15 were assigned, based on style-critical arguments, to the manufactories Bois d'Epense, Creil, Lunéville, Niderviller, Saint-Clément, Sarreguemines and to unknown factories in Lorraine. Three are stamped. Most have Ca-rich bodies with frequent lead (Pb) frit admixtures. The glaze is very often not a transparent lead glaze, as would be sufficient for a white body, but a white, tin opacified glaze. If the application of an opaque white glaze is necessary to mask the mostly red color of the ceramic body of a faïence, it is really not useful for white earthenware bodies where a transparent lead glaze would have sufficed - especially since tin was an expensive ingredient. This procedure may have been motivated by the fact that the transparent lead glaze was soft, easily corroded and prone to cracking [BO27]. An opaque tin glaze has two advantages [BR44]: it is hard and therefore does not allow itself to be easily scratched by forks and knives, and it is very suitable for covering a Ca-rich body, whether colored or not, because its coefficient of expansion is comparable [MU57, TI09, TI98].

The bodies of the 150 white earthenwares from Bordeaux were produced 1830-1885 by a mixture of H-Al clays + calcined flint ± feldspar [BE20]. 76 Pb glazes of sherds from the JOHNSTON-VIEILLARD manufactory (1835-1895) contain significantly boron, between 2.5-10 wt% B_2O_3 [BE21]. In the 19th century, ceramic technicians quickly realized that adding boron increased the hardness of a Pb glaze [SAL57].

White earthenware recipes of the Swiss factories on Lake Léman

The following is a short summary of relevant archaeometric and historical research devoted to the main white earthenware production centres on the shores of Lake Léman [SI95] [MA17, MA18] [MAG17, 17-31]. White earthenware production started 1790 in Nyon, 1791 in Les Pâquis and 1803 in Carouge, both close to Geneva (Fig. 9.1). In Nyon, for more than hundred years (1790-1930) only CaO- and MgO-rich pastes were used. This also applies for the Carouge factories for the period 1803-1880. In 1880, a radical break occurred in Carouge where CaO-poor (0.2-1.6 wt.%), SiO_2 - (70-79 wt.%) and Al_2O_3-rich (16-23 wt. %) crockery was produced until 1936. The chemical composition and the microscopic appearance of 28 objects analyzed reveal similar artificial paste mixtures in both Nyon and Carouge factories, as written in his notebook by ANTOINE LOUIS BAYLON (1812-1866), a Carouge factory owner [MA17]. The ingredients were: sand (from the Cruseille regional source) + white firing clay from Germany (Cologne) + Pb frit + chalk + Morez white + gypsum. The «Morez white» is most probably the source of the magnesium, but we actually know neither its exact nature

(Pure dolomite? Rock or mineral?) nor its origin. According to BAYLON, this ingredient replaces the chalk from France (Champagne) of earlier recipes, from which one can deduce that it must be a local carbonate. The practice of adding Pb frit to calcium-rich pastes comes from the manufactures in Lorraine who used them as an additional flux to the main carbonate flux (chalk from Champagne) to promote even better reactions during firing and to lower the firing temperatures. In conclusion, the white earthenware producers of Carouge and Nyon applied in the 19th century well established 18th century Lorraine techniques.

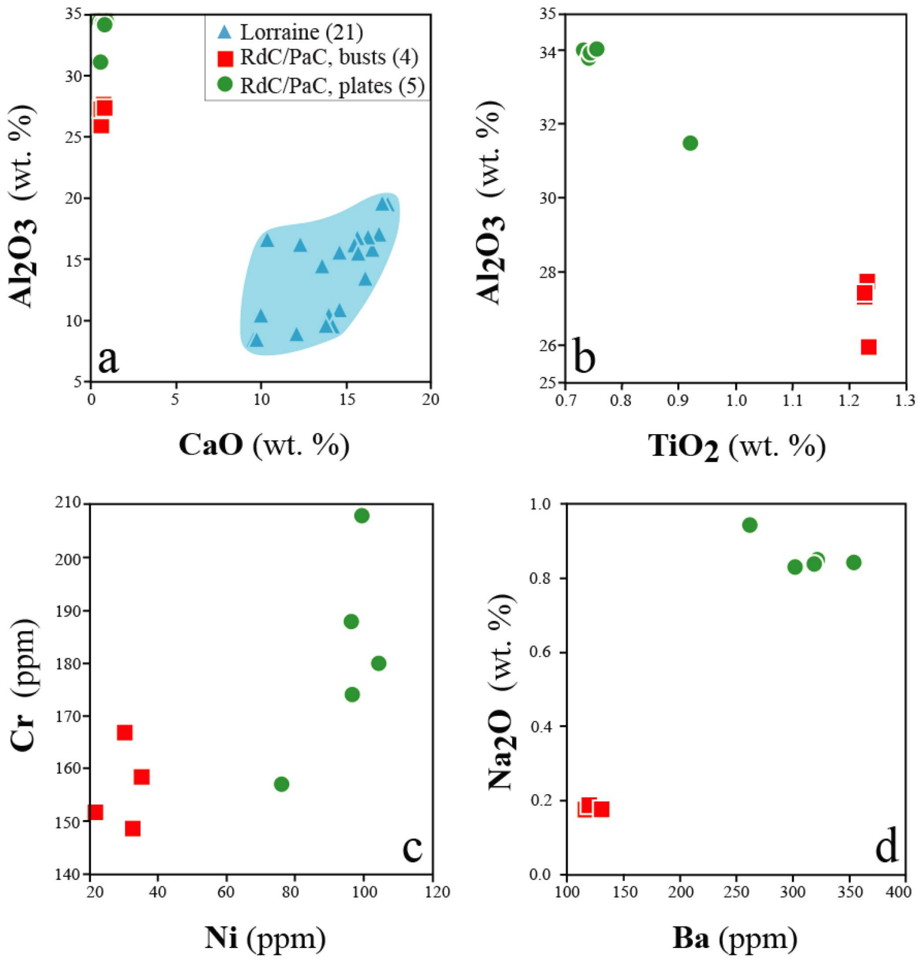

Figure 9.7: *Chemical differentiation of French white earthenwares from the « Rue de Charenton/Pont-aux-Choux » (RdC/PaC), Lorraine (Lunéville, Niderviller, Saint-Clément, Sarreguemines) and Bois-d'Épense (« Les Islettes ») manufactories. Number of analyses in brackets. Drawing* MARINO MAGGETTI.

The arrival, in April 1788, of PIERRE VERNI DE VILLARS, « fabricant de poterie qui se disait Anglais » [pottery maker who called himself

English] [SI95, 25] in Geneva was the starting point for the creation of a white earthenware company in « Les Pâquis » (Fig. 9.1). DE VILLARS left Geneva on May 17, 1789 [SI95, 39], after having unsuccessfully experimented with an earth from C (= local clay from Collonge sous Salève or imported clay from Cologne?) + added quartz, but the ceramic mass remained difficult to work. Furthermore, he had failed to find a suitable glaze that would not crack when cooled [SI95, 37 & 47]. The directors of the company had no practical experience and called on CHARLES-FRANÇOIS EXCHAQUET (1746-1792), a mining engineer, who turned to another raw material, the white earth of Larnage (Drôme Department in Auvergne-Rhône-Alpe, Fig. 9.1). This raw material is a clay of exceptional quality, which owes its white color to the kaolin present in a large proportion in its composition [WI24]. A chemical analysis of the so-called « Feldspath de l'Arnage (Drôme) » can be found in [BR54, III, tab. VI, no. 12] showing 64.8 wt. % SiO_2, 22.10 wt. % Al_2O_3, 6.50 wt. % Na_2O and 3.20 wt. % K_2O. The analysis is missing in the first edition of BRONGNIART [BR44]. EXCHAQUET experimented in Mid-1789 with various additions (Quartz, calcined flint, lead white or baryte) to the Larnage material, but without concluding results [SI95, 47-48]. GEITNER, a passing German worker, proposed a mixture of 4 parts Cologne clay + 3 parts quartz + one part chalk. This recipe is very similar to that used in Lorraine. But GEITNER was unable to find a good glaze for this kind of body. After many further attempts, also with a magnesium-rich raw material from Piemont (Baldissero close to Ivrea), a good mixture for the ceramic mass was most likely found in September 1790, consisting of Cologne clay + quartz sand from Cruseille [CO77, 134-140] [MA17, 131] + chalk (probably from Champagne). EXCHAQUET then managed to develop a well-adhering glaze consisting of 3 parts litharge + 1 part potash to which approximately 2 parts of Morez sand were added [SI95, 53]. It was finally in the spring of 1791 that the « Les Pâquis » factory became operational [SI95, 58]. The chalk was replaced by gypsum from Roche (Swiss Canton Vaud) at the beginning of the summer 1791 [SI95, 50-51]. In « Les Pâquis », white earthenware was produced for a few years, from 1791 to 1796 (For the years 1794-1796 see [SI95, 124-131]), but no examples are known to date. Recently found documents by one of us (PV), not published to date, attest that PICTET proposed around 1794 to French political leaders the sale of the white earthenware stock from Le Pâquis. But for various reasons, his proposal was ultimately not accepted, despite the interest expressed. No chemical analyses are therefore available, but based on archival recipes, the « Les Pâquis » white earthenware should have a Lorraine-type calcium-rich body and a potassium-rich lead glaze.

Figure 9.8: *Teapot attributed to Lunéville (An. No. TBL 1). Molded decoration with flowers. Late 18th century. White earthenware (« Terre de pipe »). H: 12 cm. Private collection. Photo* MARINO MAGGETTI.

Figure 9.9: *Milk jug [?]. White earthenware, Cobalt blue brush decoration. Blue paint mark « 1735/Rouen/L.C. ». Height: 16 cm, Diameter (⊘) of the base 6.5 cm. [DE07, 26] [MAI08, 84] © Musée de la céramique, Rouen (https://museedelaceramique.fr/fr/oeuvres/pot-a-lait).*

«William Tell» decorations printed on French and Swiss white earthenware («faïence fine») plates: state of the art and open questions

The history of the first printed decorations, which appeared during the revolutionary era on French and probably Swiss white earthenware, remains very poorly known to this date. Although there has been some significant progress recently [VA09, VA11, VA12a], a number of questions remain unanswered. A group of printed plates, having as their theme the story of the famous Swiss hero WILLIAM TELL, constitutes an emblematic case of this state of knowledge which will be addressed in this article. The characteristics of these printed «WILLIAM TELL» decorations are multiple: rustic, even archaic appearance both in the style of the engravings and in the technique used, with various visible defects. However, their origins and dating remain unclear. It was shown that these engraved white earthenwares could be linked to the revolutionary era and to the Geneva factory « Les Pâquis » in Switzerland [VA12a]. This has been contested by MAIRE [MAI14, 11-27] because:

(1) the Geneva factory ceased definitely its activities in August 1796 [SI95, 133] and (2) some of these «William Tell» decorations were directly inspired by engravings found in the writings of JEAN-PIERRE CLARIS DE FLORIAN (1755-1794), published for the first time in 1798/1799 as posthumous work [AN98], but written before 1794, then widely reissued subsequently (e.g. [CL00]). Thus, according to MAIRE [MAI14, 27], the «William Tell» decorations applied on white earthenware could in no way be linked to the revolutionary period or to Switzerland because they had been made in Aumale (Normandy, Department of Seine-Maritime) around 1830 (Fig. 9.1).

« Geneva (Les Pâquis)-La Balme »: a nomad factory that moved from Switzerland to France

PIERRE VERNI DE VILLARS acted as the first director of the « Les Pâquis » factory near Geneva (Fig. 9.1) from April 1788 to May 17, 1789, and was replaced by JACOB BINET (1756-?), a former goldsmith [SI95, 34-39]. The latter took the decision to have the entire contents of the factory including tools, clay, equipment, furniture, and also the stock of white earthenware already manufactured, moved into another place outside of Switzerland [SI95, 131-134]. This is how in September 1796, BINET found himself in France, in a former Carthusian convent located on the banks of the river Rhône, placed at his disposal by the French army, located more precisely in « La Balme-les-Grottes », near Salette, about 50 km east of Lyon (Fig. 9.1). This fact is interesting because it raises a fundamental question: How is it conceivable that the French army was required for taking in charge the moving of a very modest Swiss company, « a priori » having no strategic interest for France? The explanation lies in the personality of the first director of the Geneva white earthenware factory and his surprising network of relationships. Under the assumed name « PIERRE VERNI » hid a man of great stature, CHRISTOPHE POTTER (1750-1817). An archival document revealed that he was a close friend of the PAUL BARRAS (1755-1829) [VA12a, 143-145], leading member of the Directory. Such a privileged link could explain the extraordinary mobilization of the French army.

Highlighting new criteria for an attribution to «Geneva-La Balme»

The macroscopic analysis of 22 plates attributable to « Geneva-La Balme » (all 22 plates from the VALFRÉ collection), mainly with a «William Tell» decoration, and another group attributed to Aumale (10 plates, also from the VALFRÉ collection) reveals clear differences.

Glaze

On certain « Geneva-La Balme » plates, we sometimes notice protruding impurities stuck to the glaze, visible to the naked eye. The most interesting criterion however is on the reverse side of some of them (Fig. 9.10a). Unlike the plates from all other French white earthenware manufactures, the surface

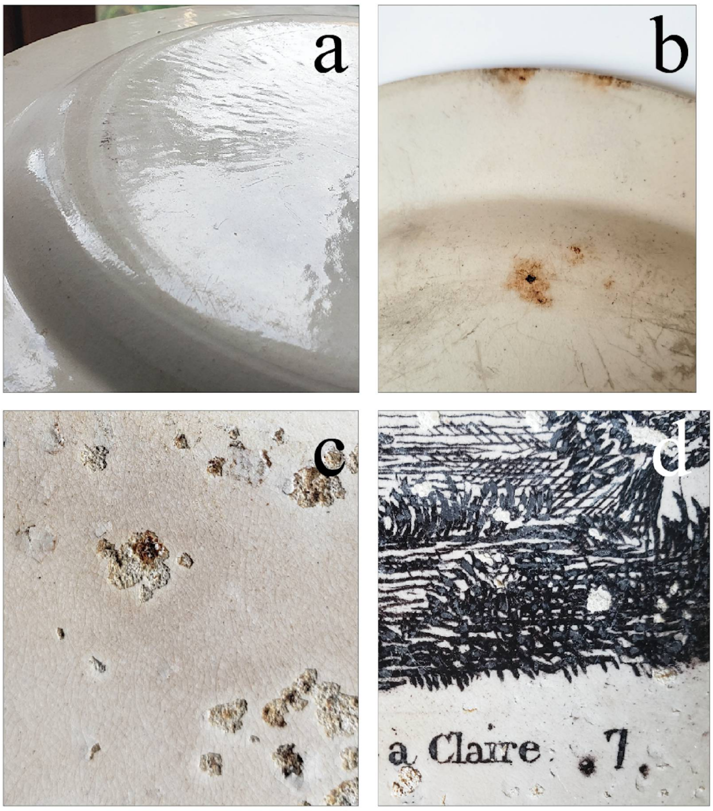

Figure 9.10: *Macrophotographic details of dishes attributed to the « Geneva-La Balme » manufactory. (a) Reverse of a plate, showing slight glaze excesses characterized by discontinuous lines, oriented from the center outwards. Legend without number. VALFRÉ coll. no 6, « Gesler fait enchainer Gme. Tell » [Gesler has W. Tell chained]; (b) Ferruginous particles in the ceramic bodies. When oxidized, they can sometimes burst the glaze. 4x5 cm. VALFRÉ coll. no 4, « Gesler oblige les habitans de saluer sa toque. Gme. Tell s'y refuse! » [Gesler forces the inhabitants to salute his hat. W. Tell refuses!]; (c) as (b), but another plate. VALFRÉ coll. no 11; (d) The new paste with ferruginous particles appears concomitantly with numbered legends and a new uniform glazed, produced by dipping. 3x4 cm. VALFRÉ coll. no 11. Photos* Patrice Valfré.

there of certain plates is not really smooth, but reveals slight over thicknesses forming discontinuous radiating lines, oriented from the center outwards. This particularity can be felt by touch and is even more perceptible with grazing light. It was observed on approximately 6 out of 20 plates, indicating a particular glazing technique, which, according to the knowledge of the co-author (PV), remained undocumented until now. The technique was very simple: A small ladle of the liquid raw glaze mixture was applied in the center of the inverted plate, which was spread using a brush or coarse-haired paintbrush, making movements going from the center towards the wing.

This criterion is not found on any other French white earthenware from Aumale, Montereau, Choisy, Creil or other production sites. There, the raw glaze mixture was applied by dipping, with a uniform and smooth final result on both sides of the plate. This rare technique can therefore be considered as an identification criterion, specific to a part of the white earthenware production belonging to the « Geneva-La Balme » group. It further attests to a method of manufacturing that remained at a very artisanal stage and consequently, we can position it chronologically as belonging to the first phase of « William Tell» decorations production.

Ceramic body

A noticeable characteristic present in the ceramic body of the group attributed to «Geneva-La Balme» are traces of rust visible in some places, originating from black dots in the paste and still visible under the cover (Fig. 9.10b). These imperfections appear on nearly 30% of the pieces studied. Observation with a magnifying glass reveals that these dark dots are probably ferruginous particles (former pyrite flies?). As they rusted, these particles increased their volume and could sometimes raise or burst the overlying glaze (Fig. 9.10c, d). How can such a penalizing defect, from a commercial point of view, be explained? It is very likely that this defect was not immediately apparent at the time of sale, and that it probably appeared only after prolonged use and numerous washings.

A document found in the national archives of France in Pierrefitte attests that the Genevan local clays did not give complete satisfaction: «[...] Plusieurs savants et artistes genevois ont fait à ce sujet des recherches très suivies ; ils sont parvenus à trouver une pâte aussi bonne que celle des Anglais et l'on est instruit qu'ils ont tiré pour cet effet leur terre de France, ce qui leur a coûté le plus de peine, c'est de trouver un vernis qui pûs s'y adapter». [[...] Several Genevan scholars and artists have carried out very detailed research on this subject; they managed to find a paste as good as that of the English and we are informed that they took their clay from France for this purpose, what cost them the most trouble was finding a glaze which could adapt to it] (AN: F12/1556). This confirms SIGRIST/GRANGE's [SI95, 37 & 47] statement quoted above. Based on this observation of the presence of undesirable particles, it can be deduced that the clays were not sufficiently purified. Today, similar ferrous grains are for example also found in the stoneware clays from Puisaye [SOL24]. Could it be that the Genevan factory imported such French stoneware clays to increase the resistance after firing due to the presence of kaolin, despite the additional cost generated by the transport? It must be recalled that one of the qualities somewhat forgotten today, making the English white earthenware (Queensware) so desirable at that time, was the fact that they were refractory. In other words, they could go into the oven and withstand high heat without suffering the slightest deterioration.

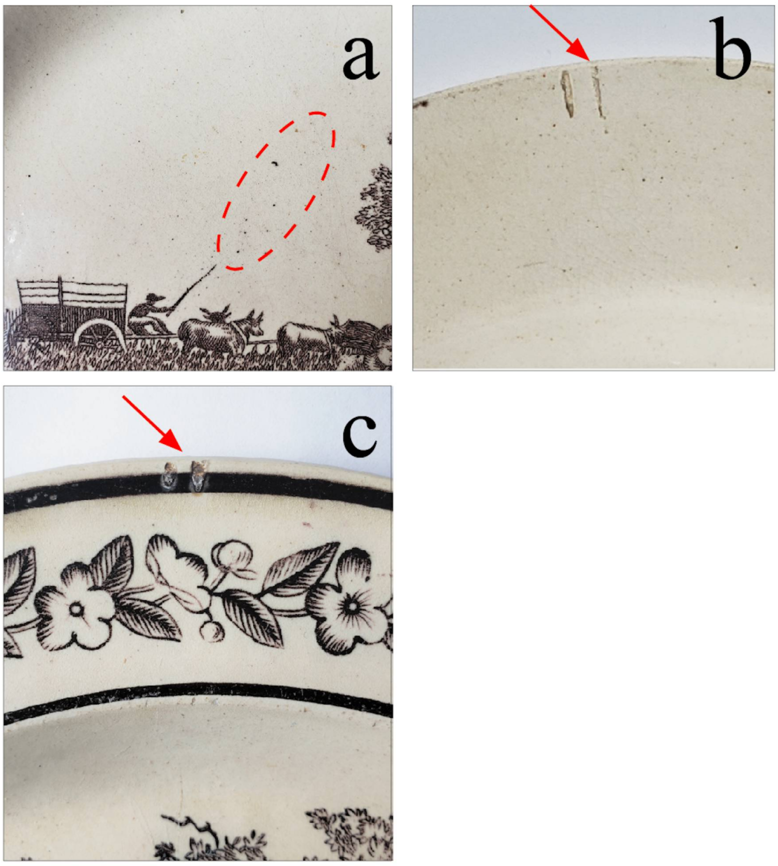

Figure 9.11: *Distinguishing criteria found on some white earthenware attributed to « Geneva-La Balme ». (a) Unwanted dusting of metal oxides in the red dotted oval, not cleaned before applying the glaze. 7x5 cm. VALFRÉ coll. no 3; Traces left by the firing supports visible not only on the reverse (b) but sometimes also on the obverse (c). 5x7 cm. VALFRÉ coll. no 8, « Gesler demande pourquoi cette seconde flèche . . . » [Gesler asks why this second arrow . . .]. Photos* P*ATRICE* V*ALFRÉ.*

Transfer print technique

Some particularities are specific for the transfer print decoration technique attributed to the « Geneva-La Balme » group, such as occasional fingerprints or involuntary oxide sprinklings, not removed before applying the raw glaze mixture (Fig. 9.11a). This defect reveals a primitive technique of applying such a transfer print decoration. It corresponds to that described in the patent application filed by CHRISTOPHE POTTER in June 1789 [VA12a, 88-94] and consisted of using an oil to fill the hollow engraving made on metal. Then, this oil print was removed and transferred to the ceramic using a support (either a pad made of strong glue or with a thin paper). Once the oil drawing was placed on the unglazed (bisque fired) ceramic the worker took a metal oxide powder using a cotton wick, which he then tapped on top of the fresh oil drawing, until it was saturated. It was then necessary to carefully remove all excess oxide that had fallen next to the oil decoration, before moving on to the next phases, i.e. the drying and application of the glaze and the final glaze firing. This cleaning operation was carried out either by blowing or using a brush. Understandable, this way of doing was as delicate as time-consuming and was therefore subsequently replaced by mixing the oil and the oxides before the transfer operation.

Traces of plate's support in the kiln (spur)

It is common knowledge that before firing, the plates were placed in saggars, separated by ceramic supports (spurs), in order to avoid any sticking together. There are frequent traces of such kiln spurs. What is special about it, is the fact that they are visible not only on the reverse (Fig. 9.11b), which is classic, but sometimes also on the obverse (Fig. 9.11c). However, this criterion seems significantly less relevant than the others because, although very rarely, it can be seen on the Aumale products.

Towards a production timeline

Figure 9.12: *(a) Plate attributed to « Geneva-La Balme » with a «*W*ILLIAM* T*ELL»-type decoration. Legend: « Gesler demande pourquoi cette seconde flèche? Gme Tell / lui répond pour te percer le coeur si j'avais tranché les jours de mon fils. » [Gesler asks why this second arrow? W. Tell / responds to pierce your heart if I had ended my son's life.] Border with apple blossoms decoration. ⊘: 23,8 cm.; (b) Detail showing the re-engraved bell tower (red arrow), characterized by a significantly thicker line than the other parts of the transfer print decoration. 8,5x11 cm. VALFRÉ coll. no 8. Photos* P*ATRICE* V*ALFRÉ.*

The study of the transfer print decorations offers the possibility of discerning two distinct temporal phases, probably quite close to each other and even, a partial wear of the engraved copper plates due to an intensive use. To illustrate this fact, a close observation of the decoration of a plate captioned: « Gessler demande pourquoi cette seconde flèche? » [Gessler asks why this second arrow?] (Fig. 9.12a), shows that the copper plate which served as a matrix for the printed decoration, has been partially re-engraved due to a wear that has become excessive by places, as for example the church tower where the impression line is significantly thicker (Fig. 9.12b). On the other hand, on two plates with similar decorations (Fig. 9.13), captioned « Guillame TELL cultive la terre des indigens qui n'ont pas d'outils » [William Tell cultivates the land of the natives who have no tools], a perfect glaze made by soaking can be seen, as well as an underglaze number 9 at the end of the legend on the obverse (Fig. 9.13b). The goal of this modest innovation was certainly to make the story easier to read and tell. From these improvements the deduction can be made that this plate should be positioned chronologically after those without a numbered legend and covered by a brush-applied raw glaze on the reverse.

Figure 9.13: *Two plates attributed to « Geneva-La Balme » with a «William Tell»-type decoration. Legend in (a): « Guillaume TELL cultive la terre des indigens qui n'ont pas d'outils » [William Tell cultivates the land of the natives who have no tools]. ⊘ 23,8 cm. VALFRÉ coll. no 2; same legend in (b), but with a number 9 at the end (highlighted by a red arrow) and an oxidized ferruginous particle (red circle). Its glaze on the reverse is perfect. Both borders with apple blossoms decoration. ⊘: 24 cm. VALFRÉ coll. no 3. Photos Patrice Valfré.*

Two conclusions can be drawn from these various criteria and observations: (1) A great number of «William Tell» transfer printed plates must have been produced, especially if one considers that the worn engraved plate was made of copper; (2) The appearance of a numbering after the legend, jointly with the better quality in the glaze application allow to consider a chronological differentiation. Furthermore, the fact that the number is placed at the end of the legend and not, as usual, at the beginning denotes and reinforces the pioneering aspect of these transfer print series with «William Tell» decoration. As already mentioned, these plates with numbered legends haven't on the reverse a glaze with radiating lines, which attests that at a given moment multiple technical innovations appeared. In other words, a radical change must have occurred in the glaze's application technique with a soaking in a container full of the liquid raw glaze mixture, which had most probably a slightly different composition from the previous one. This allows to consider the plates with a good uniform glaze, applied by dipping, and as those with a numbered legend, as being posterior to those bearing a brush cover on the reverse and a legend without a number.

Would it be possible to suggest a date for the appearance of these various technical improvements? There is a tempting track, especially considering the fact that in Spring 1792, CHRISTOPHE POTTER, the hidden shareholder of the Geneva « Le Pâquis » factory [VA17, 174], sent a group of four of his most competent technicians on a mission from France to Switzerland [SI95, 112]. One is tempted to link the arrival of this qualified team with these technical innovations. Actually, the hypothesis cannot be excluded that BINET, once established at « Geneva-La Balme », made also certain improvements. In September 1792, a new kiln became operational in « Les Pâquis » [SI95, 112]. Unfortunately for the young company, the French Revolution hit Geneva two years later. An economic crisis followed, forcing PICTET to have to send back a part of his English team, which was quite expensive in terms of salary, probably at the end of December 1792 or at the beginning of 1793, since Wood came back to France.

The « Les Pâquis » manufactory in French archival documents

The French archives have provided interesting documents concerning this white earthenware factory in Geneva. They highlight serious technical difficulties in the development of a perfect glaze: « Ils ont trouvé une pâte aussi bonne que Wedgwood et qu'il ne leur manque plus qu'à composer un vernis qu'y puisse s'y adapter » [They found a paste as good as Wedgwood and all they need to do is to compose a glaze that can adapt to it] [VA12a, 64]. Another document confirms this: « Manufacture de terre de pipe établie à Boterve, sur le territoire de Genève [....] ce qui leur a coûté le plus de peine c'est de trouver un verni qui pûs [sic] s'y adapter; on assume cependant qu'ils ont réussi » [Manufacture of terre de pipe established in Boterve, on the territory of Geneva [....] what cost them the most trouble was finding a glaze which could adapt to it; we assume, however, that they succeeded] [VA12a, 64].

An early implementation of the transfer print method in « Les Pâquis »?

Concerning the possibility of the implementation of the transfer print technique during the revolutionary era in Geneva, several written sources confirm this hypothesis. On the one hand it is known that « Les Pâquis » paid 1789 six gold Louis to a certain MUNNER [SI95, 95]. The manufactory intended to profit from this investment, as it was a notebook detailing the technique of the transfer print decoration. On the other hand, PICTET, GOSSE and BINET received delivery on April 4, 1791, of a set of copper plates ordered a year earlier and produced by the engraver JEAN-FRANÇOIS HESS (1740-1814) [SI95, 95]. This would possibly suggest that the introduction of the transfer print method could have started shortly after, but unfortunately, the Revolution which occurred in Geneva at the end of 1792 was accompanied by an economic crisis which seriously hampered the development of the very young company. As a fact, no trace is to be found concerning the effective implementation of this new decoration technique at « Les Pâquis », between 1791 and 1796, in the correspondence of PICTET or the other protagonists.

But luckily, a document, published in Paris in 1806, definitively removes all ambiguity on this subject: « La méthode à l'aide du tampon de colle forte avait été pratiquée avant la Révolution par un de nos collègues, un savant qui cultive les sciences et les Arts pratiques, M. Pictet, dans une manufacture qu'il avait près de Genève » [The method using the thick glue pad had been practiced before the Revolution by one of our colleagues, a scholar who cultivates sciences and practical arts, Mr. Pictet, in a factory he had near Geneva] [GI07, 61]. In another article, PICTET gives numerous technical details attesting to his knowledge and his perfect mastery concerning the transfer print technique with thick glue pad, used as an ink pad [AN05, 223-224]. It should be noted that the chronological aspects in the above cited text does not refer to the French Revolution of 1789 but rather to the one in Geneva, which occurred three years later, in December 1792.

DEVILLARS-POTTER, an important, but forgotten historical figure

A little more must be said about a totally extraordinary character, who has gone somewhat unnoticed until now. This person was CHRISTOPHE POTTER (1750-1817), who went to hide for a full year in Geneva between 1788 and 1789, where he took the alias DE VILLARS (or DEVILLARS) [VA17, 174]. Assembling many scraps of information from archive documents and some old publications, his story could gradually be reconstructed, a story similar to a real novel but nevertheless very real.

This man of truly superior intelligence had first been a wholesale trader in London, in the bakery sector, and also a supplier of food rations for the English troops sent to fight the American insurgents. He had even become a member of the British Parliament, with a brilliant future until an unexpected accident changed the course of his life, forcing him into exile. The reason of this accident was recently found in the National Archives (Pierrefitte) in a report from the French secret police of the Consulate, i. e. a duel between WILLIAM PITT the Younger (1759-1806) and POTTER, during which the latter was seriously injured [VA12a, 29]. The virulent antagonism between both men is understandable: (1) POTTER campaigned for American independence, unlike his opponent; (2) Finally PITT had become Prime Minister in 1783, a position also coveted by POTTER who succeeded in obtaining the support of the Prince of Wales, future King of England as GEORGE IV, who acted also as Grand Master of the English Freemasonry. According to recent crosschecks (by PV), this duel, where POTTER has been injured, must have taken place in London or the surrounding area, between August 1787 and January 1788, however no trace of it can be found in the gazettes of the time. These dates can be inferred from cross-checks knowing that on the one hand, PICTET became friend with him during his stay in England in 1787, and on the other hand, that POTTER came to stay in France at the beginning of 1788, more precisely in Villers-Cotterêts, in the stronghold of the Duke of Orléans, Grand Master of French Freemasonry. A police report relating to his stay is very explicit: « Sa société étaient celle des plus grands seigneurs. » [His society was that of the greatest lords] [VA12a, 33]. Then, for some reason which remains unknown to us, POTTER, under the pseudonym DEVILLARS [VA17, 174], came to find refuge in Geneva in April 1788 [SI95, 34] where he remained for almost a year, probably the time of his convalescence.

The knowledge previously acquired in England in the field of ceramics allowed him to become an associate of the pharmacist HENRI ALBERT GOSSE and the PICTET brothers, under the alias PIERRE VERNI DE VILLARS as already explained. He served there as director of the white earthenware factory « De Devillars & Compagnie », established in « Les Pâquis », a company in which each of the partners owned a quarter of the shares with the advantage for POTTER of having obtained his shares free of charge, in exchange from his know-how. He also benefited from an annual income of 50 Louis d'or and remained in this position until May 17, 1789, the day of his final departure for France where the first thing he undertook was to file, in June 1789, a request for a privilege, i. e. the ancestor of the invention patents, on the transfer print decoration [VA12b, 77]. This association between three Genevans and a freshly arrived Englishman may be surprising in its speed. However, when one knows that the PICTET brothers had probably met POTTER during their stay in London in 1787 where they had established a bond of friendship, it is better understood. In addition, there are other more significant facts after 1789 attesting the constant links maintained between POTTER and the Geneva manufacture. First of all, there is FERDINAND MULLER, the cofounder with JEAN-ADAM MULHAUSER of the first « Les Pâquis » white earthenware factory, active between 1786 and 1788, and bought soon after by the new company « Devillars & Compagnie ». According to a recently published archival document, MULLER joined POTTER in France where, from 1789-1790, he had become his main workshop leader in Paris initially, then later in Chantilly [VA16a, 34]. Secondly, POTTER continued his involvement in Switzerland manufacture having asked in 1792, as already shown, four of his qualified technicians to move to Geneva. Among them was the turner SAMUEL KERRAT and another the very competent GEORGES WOOD, with whom POTTER subsequently joined forces in 1797, at Forges-les-Eaux, by providing the financing of this new white earthenware (creamware) factory and later a porcelain factory at Gournay-en-Bray. It should be noted that in

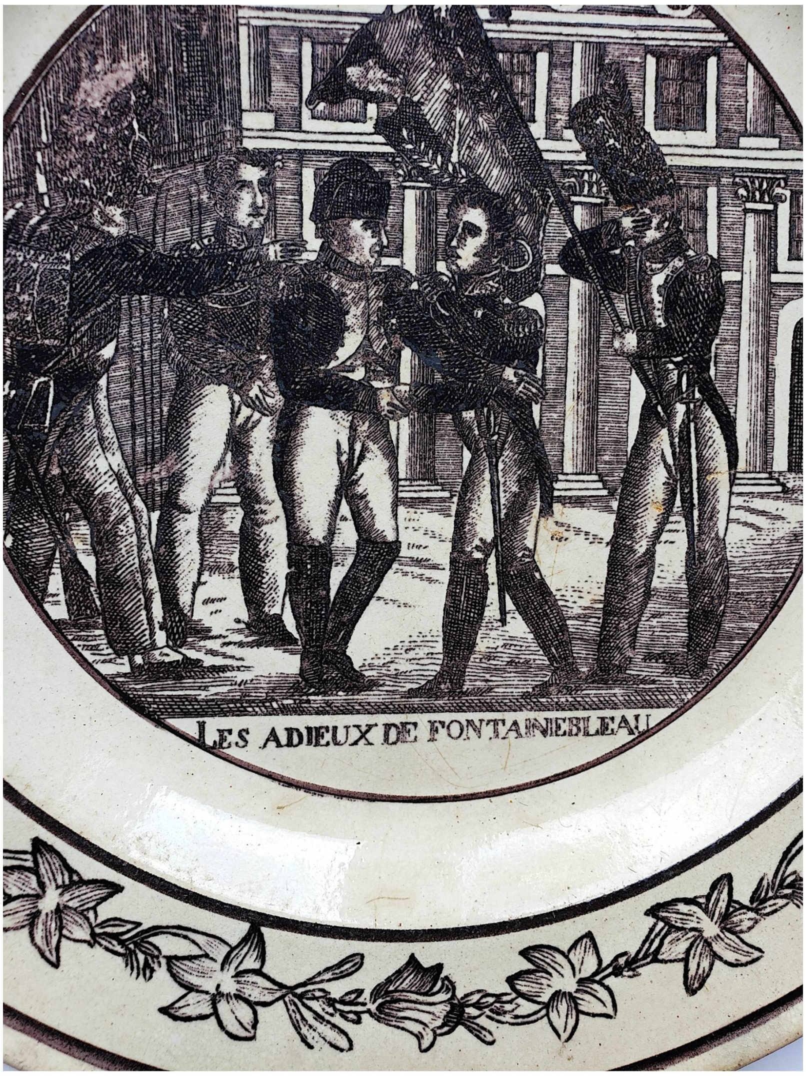

Figure 9.14: *Detail from a plate attributed to Aumale (1824-1830). Legend: « LES ADIEUX DE FONTAINEBLEAU » [THE FAREWELLs FROM FONTAINEBLEAU]. On the marli, peripheral frieze of fleur-de-lys similar to those on « Geneva-La Balme » plates. 12,5x15 cm. ⊘ of the plate: 24 cm. VALFRÉ coll. Photos PATRICE VALFRÉ.*

1796, when BINET, prior to moving the « Les Pâquis » factory to France, bought all the shares in the company, he most likely did so on behalf of POTTER. Thirdly, a final testimony of these multiple crossing links: in May 1797, GOSSE, the former shareholder of « Les Pâquis » and a close friend of the director of French manufactures, ROLAND DE LA PLATRIÈRE (1734-1793) and his wife MANON (1754-1793), visited (perhaps stayed there?) the POTTER factory, probably at Chantilly, rather than Montereau, during his new stay in France: « Je laisserai aussi la fabrique de Potter; son travail m'a paru inférieur à la poterie que nous fabriquions. » [I will also leave the Potter factory; his work seemed inferior to me to the pottery we made.] [PL09, 351].

Looking for a link between POTTER and MÉRY

After having established the macroscopic distinction between the white earthenware produced in « Geneva-La Balme » and in Aumale, an important question remains: how to explain the fact that the same borders, printed on the Aumale plates are similar to those with « William Tell » decorations from « Geneva-La Balme », but with a time gap of almost 40 years between both groups (Fig. 9.14, 9.15)? With POTTER, a person who established a true cult of secrecy in all his activities, nothing is simple. However, there must be a coherent explanation between the decorations produced lately at Aumale by JEAN FRANÇOIS MÉRY (born around 1770) [VA20, VA16a] and those at « Geneva-La Balme », which remained to be discovered. Research work of one of us (PV) on POTTER finally discovered indirectly a link between him and MÉRY. The latter had applied in March 1813 for a patent for transfer print decorations [VA12a, 328-330], which is extremely close to that of POTTER fallen into public domain in December 21st,1812. Then, under the name « MÉRY & COMPAGNIE », he established in Paris a printing company, active between 1815 and circa 1820, and finally a transfer print white earthenware factory in Aumale (Department 76), active between 1824 and 1830.

Figure 9.15: *Two plates attributed to Aumale (1824-1830) with similar decorations on the marli as on « Geneva-La Balme » plates. (a) Legend: « BATAILLE DE WATERLO. La Garde meurt et ne se rend pas » [BATTLE OF WATERLO. The Guard dies and does not surrender]. Peripheral frieze of apple blossoms on the marli. ⌀: 22,4 cm; (b) Legend: « ÉGLISE NOTRE DAME / À Paris » [CHURCH NOTRE DAME / In Paris]. Discontinuous peripheral floral frieze on the marli. ⌀: 21,5 cm. VALFRÉ coll. Photos Patrice Valfré.*

On the other hand, a writing of POTTER, sent 1801-1802 for the renewal of his demand concerning his patent application, done this time jointly with his son THOMAS, tells that he had never stopped, since 1789, to be interested and to make constant improvements to its production of transfer print decorations [VA12a, 95]. But it is above all a series of cross-references which allows to understand that within CHRISTOPHE POTTER's companies, MÉRY had been his main technician in charge of the transfer print decoration. Its exact role appears by observing the progress of the very clever multiple sales of POTTER's transfer print decoration patent. Indeed, it appears that in most sales, MÉRY was responsible for carrying out the technical transmission to the new buyer. It was the case around 1807-1808 in Choisy-le-Roi for the transmission to the PAILLARD brothers - former tenants of the Potter factory in Chantilly [VA12a, 330] [VA20, 24], then 1808 in Sèvres, during the sale to the Count of Puibusque [VA12a, 328]. Although no document attesting it, he must have been in charge of the transfer printing in the initial period (1803-1808) of Creil, in helping JOHN H. STONE, before the latter left Creil after having obtained in 1809 his own patent and established himself in Paris. POTTER was STONE's masked associate in this affair [VA20, 161-204], and for the first period 1803 to 1808, Creil used POTTER's transfer print patent.

The delivering of MÉRY'S patent took much time, as he obtained it only in 1814, after having been forced to provide to the administration quantity of technical details, particularly on the composition of the printing ink, made of « manganèse, safre, cobalt, vert de gris, oxyde de cuivre et minium » [manganese, safre, cobalt, verdigris, copper and minium]. In a letter addressed to the minister, he claims to have carried out underglaze printing in Sèvres for more than 200,000 francs and to be capable of printing « non seulement en noir mais en toute autres couleurs qu'on voudrait » [not only in black but in any other colors we want] [VA12a, 92 & 329].

Examining the white earthenware printed by MÉRY in Paris, it can be seen that the decorations came mainly from the old stock of POTTER's engraved plates. In addition to the link between the two men, it is possible to draw several lessons from the presented facts. On the one hand, one realizes with astonishment that this apparent competition between the different French manufacturers of transfer print decorations on white earthenware of this period, had been planned and orchestrated by POTTER himself (he had also sold the technique of his printing patent to PIERRE NEPPEL, buyer of its former Parisian porcelain factory on rue de Crussol [VA12a, 316-317,324-325]. On the other hand, POTTER had anticipated the fact that his patent would fall into the public domain in December 1812, so he wanted before this deadline to "occupy the land" in order to thwart possible competition. The patent application filed by MÉRY the following year should be positioned in this logic. A declassified report from the Directorate's secret police (Decembre 13,

1800) corroborates POTTER's personality: « plein d'intelligence et d'adresse, on le surveille ». [full of intelligence and skill, he is being watched.] [VA16a, 16].

As for the printed borders from the Geneva-La Balme « William Tell » decorations, reused from 1824 by MÉRY in Aumale, perhaps he had kept in his possession old engraved plates previously executed in Switzerland. It could also be that he had, for economy reasons or lack of artistic creativity, almost a quarter of a century after their first use, and after the death of POTTER in 1817, the idea of reusing for his own account the floral engravings which appeared on the borders of the « William Tell » plates. However, at the actual stage of the research, it does not seem that he reproduced in Aumale the central engravings appearing on the « William Tell » plates from « Geneva-La Balme ».

In terms of a conclusion

What previously blurred the ideas and obscured all possibilities of differentiation between white earthenware dishes from « Geneva-La Balme » and from Aumale was the fact that MÉRY reproduced under the Restoration, from 1824 on, the floral borders of Geneva, as we have seen. Initially, only a difference in the glaze quality had given rise to the idea that these were two distinct productions. Actually, several distinctive criteria and even some chronological elements allow a somewhat better understanding of the « Geneva-La Balme » production. However, an exhaustive study of the « revolutionary » decorations produced by the « Geneva-La Balme » factory still remains to be done. In another register, if one takes a step back from ceramics and focus the attention only on the decorations, this way of telling a story with captioned images, certainly not on paper but on white earthenware, wouldn't that be the ancestor of the current cartoons?

The results of the archaeometric analyses discussed in the next chapters will show if the lessons learned from the visual approach and if the information provided by the archival documents will be confirmed or not.

Samples, analytical methods and aims of the research

Samples

To try to solve the questions asked, three plates with different transfer print images and legends were chosen by the second author (PV) from his rich private collection (Fig. 9.16- 9.18, Tab. 9.7). The first plate (Sample VAL 1) is attributed to the factory of Aumale, dated between 1824/25 and 1831 and shows an image of the famous Paris building « Palais du Luxembourg », the second (VAL 2) to Geneva-La Balme (1797 -1810?) with an example of a « William Tell » transfer printing – the translated legend reads « Melctal tells why his son had to run away » –, the third (VAL 3) is the only object

Figure 9.16: *Plate attributed to Aumale (Sample VAL 1). Private collection. Photo* MARINO MAGGETTI.

Figure 9.17: *Plate attributed to Geneva-La Balme (Sample VAL 2). Private collection. Photo* MARINO MAGGETTI.

that can be reliably assigned to a specific factory thanks to the press-mark « MONTEREAU », shows another famous Paris building, the « Musée du Jardin des Plantes », and can be dated around 1800 to 1815. The first and third plates, in contrast to the second, are full of cracks. The course of these cracks was used to take a sample from each, while the sample of the second plate had to be out of a slightly damaged edge area (Fig. 9.19). VAL 1 has a clearly yellowish glaze, VAL 2 only has a slightly yellowish and VAL 3 has a colorless one. Due to this colouring, the black decor of VAL 1 and 2 appears to the human eye to have a more or less intense brownish hue.

Analytical methods

Milling

For the chemical and mineralogical analyses, the glazes of the three samples were ground off. The cleaned and dried samples were then finely ground in a tungsten carbide mill by the first author. The powders obtained in this way weighed 5.1 to 7.6 grams (Tab. 9.7).

Chemical analysis by X-ray fluorescence (XRF)

The analyses were carried out in the geochemical laboratory of the Department of Geosciences at the University of Fribourg (Switzerland). 2 grams of powder per sample were calcined in an electric furnace under oxidizing conditions at 900 °C to determine the loss on ignition (LOI). Then 0.700 g of the calcined powder was mixed with 6.650 g of MERCK Spectromelt A10 ($Li_2B_4O_7$) and 0.350 g of MERCK lithium fluoride (LiF), and melted in a

Figure 9.18: *Plate from the Montereau manufacture (Sample VAL 3). Inlet: impressed trademark of this factory (back of the plate). Private collection. Photo* MARINO MAGGETTI.

Figure 9.19: *The three plates with sampled areas coloured in orange. Photo* MARINO MAGGETTI.

platinum crucible for 10 minutes at 1050 °C in a PHILIPS PERL X-2 device to form a glass pill. The main, secondary and trace elements were measured on these pills using a wavelength-dispersive X-ray fluorescence device PHILIPS PW 1400 (Rhodium cathode, 60 kV and 30 mA). The calibration was carried out with 40 internationally certified standard samples. Accuracy (accuracy) and scatter (precision) were checked with internal laboratory reference samples. The errors are below 5% for all elements.

Mineralogical analysis by X-ray diffraction

The mineralogical composition was determined through powder X-ray diffraction, using the powder left over after the confection of the XRF tablet (Philips PW 1800 diffractometer, CuK α, 40 kV, 40 mA, 2ν 2-65°, measuring time 1 sec./step).

Microscopic and chemical analysis by scanning electron microscopy

The first author analyzed the body, glaze and colour pigment of the three samples by Scanning electron microscopy (SEM). For this doing, small cross sections were cut from these objects at the permitted locations using a diamond saw. When polished, they were coated with a ca. 30 nm thick carbon layer. Backscattered electron images (BSE) were collected with a scintillator type detector out of these polished samples, using a Philips FEI XL30 Sirion FEG electron scanning microscope. The glazes were analyzed in the upper third in order to avoid contamination by the ceramic body as much as possible during firing. Chemical compositions were determined by energy-dispersive X-ray spectrometry (EDS), operated at a beam acceleration voltage at 20 kV, a beam current of 6.5 nA, 7.5 mm working distance and 50 s measuring time. Standardless quantification was performed using an EDAX-ZAF correction procedure of the intensities, using spot analyses (2 µm diameter) as well as larger area analyses of homogeneous areas. The detection limits for most elements were about 0.2 wt. %. The reliability of the results was checked measuring well known glass and mineral standards (DLH2, Corning A-D and Plagioclase). The relative mean deviation for major and minor oxide components was 2% for concentrations in the range of 20 -100 wt. %, 4 % for 5 – 20 wt. %, 10 – 20 % for 1 – 5 wt. % and > 50 % for < 1 wt. %.

Statistical treatment

The treatment of the chemical analyses was carried out by the first author with the help of the program SPSS (Statistical Package for Social Sciences), especially for the construction of the binary diagrams.

Aim of the investigation

The research tried to clarify the following questions: (1) How do the three plates respectively their ceramic bodies, glazes and colour pigments differ chemically and microscopically? (2) What conclusions can be drawn from this regarding manufacturing technology? (3) Are there any similarities with the « Les Pâquis » factory and with the archaeometrically examined white earthenwares from France (Bordeaux, Creil, « Rue de Charenton/Pont-aux-Choux ») and Switzerland (Carouge, Nyon)?

Results and discussion

Ceramic bodies

Macroscopic colour

The three ceramic bodies are coloured differently. VAL 1 is beautifully white, while VAL 2 and VAL 3 show creamy tints (Fig. 9.20). As the chemical analysis shows, the white colour can be correlated with a significantly lower iron content (Expressed as Fe_2O_3 in tab. 9.8).

Chemical composition

The results of the chemical analyses (Tab. 9.8) show lead (Pb) contents that are significantly higher than the maximum values normally found in clayey raw materials worldwide (110 ppm: [TU61]; 240 ppm: [ER61]). Such high lead contents may be due to: (1) an addition of Pb glass (frit) during the preparation of the paste; (2) an infiltration of the aqueous suspension containing the crushed glaze during their application on the porous bisque, between the first and the second firing; (3) an infiltration of the molten lead glaze into the bisque during the second firing; (4) an infiltration of Pb vapors into the

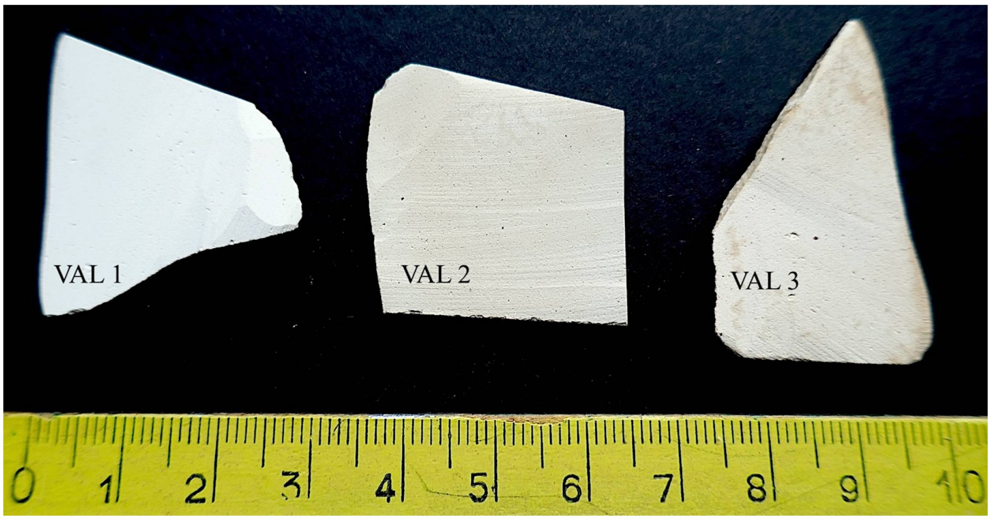

Figure 9.20: *Body colours of the three samples. Photo* MARINO MAGGETTI.

ceramic objects during the firings or (5) an insufficient abrasion of the glaze during sample preparation. The fifth hypothesis is unlikely, because great care was taken to completely remove the vitreous film. On the other hand, no fragments of a Pb frit or a Pb bearing grog could be observed in the bodies. Therefore, hypothesis 1 can be dismissed too. No argument can be put forward to decide between the remaining hypotheses. The fact that Pb infiltration has effectively taken place is shown by profile measurements [MA18], but it cannot be decided to what extent the three remaining mechanisms can each be held responsible.

The three analyses contain only four oxides (SiO_2, TiO_2, Al_2O_3, Fe_2O_3), whose concentration exceeds 1 wt. %, the sum of silica and alumina totalizing alone 94 – 95 wt. %. Therefore, the objects belong to the aluminous white earthenware subgroup [MAG17, 160]. The alkali content is useful to distinguish the « cailloutage » from the « porcelaine opaque » (feldspathic or ironstone) type [BR44, II,112-113]. The first consists only of a mixture of highly plastic clay and crushed flint or quartz. In the second, kaolin and weathered feldspar or pegmatite were added [BR44, II,114-115]. The alkali content must therefore be higher, as an analysis of a « porcelaine opaque » attributed to Creil with 1.12 wt. % (recalculated to a sum of 99.99 wt.%) shows [BR54, II,694] respectively 1.10 [SAL57, 357]. The alkali contents ($Na_2O + K_2O$) of the examined objects are well below 1 wt. %, just like those of Creil-1 and Creil-2 (Tab. 9.8). These objects belong therefore all to the « cailloutage » type. Contrasting, the significantly higher Na_2O and K_2O contents of sample TBL 2 from Saareguemines shows that in this contemporaneous factory Na- and K-containing additives were incorporated into the recipe very early on in order to produce «porcelaine opaque». VAL 2 has a significantly higher LOI than both others which would be consistent with a lower firing temperature.

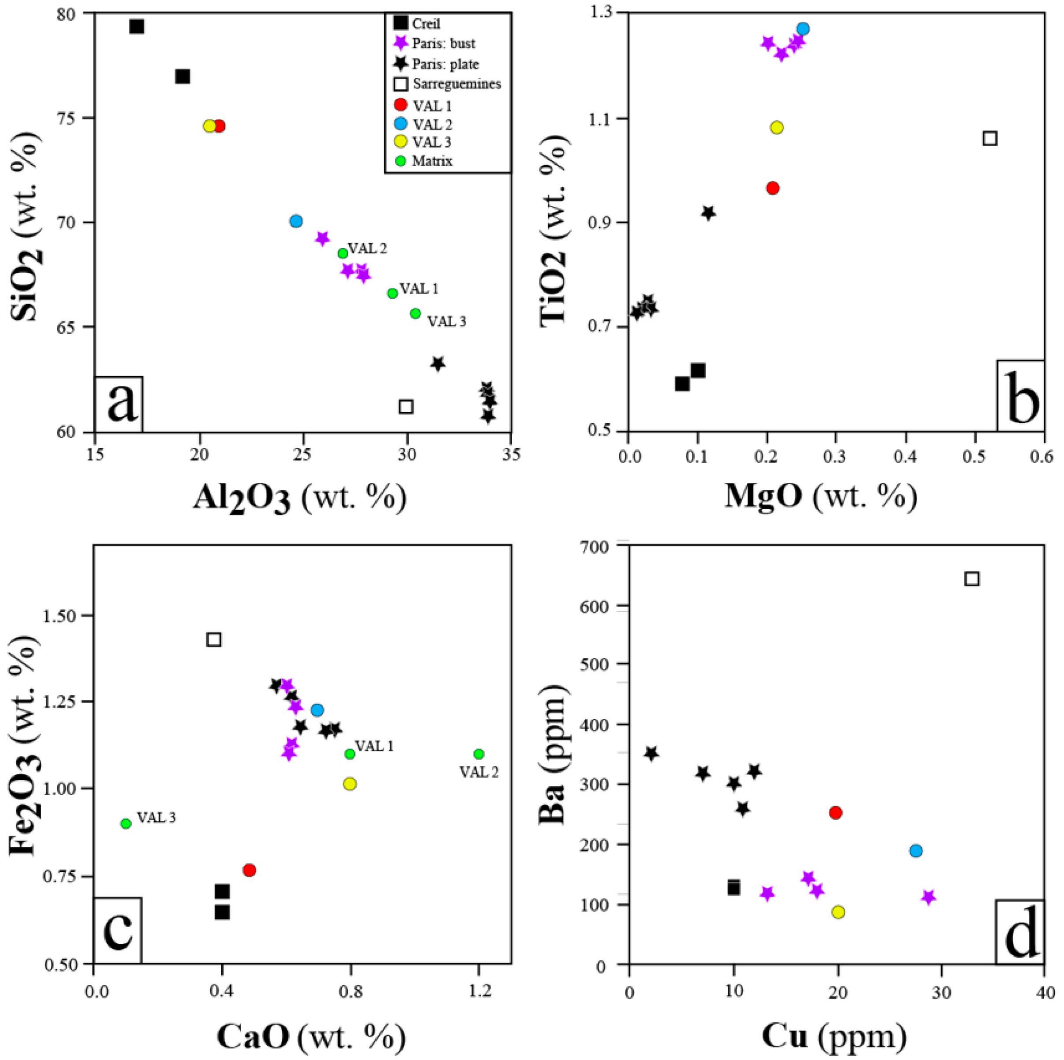

Figure 9.21: *Body (bulk) compositions displayed on bivariate plots of selected oxides and elements (Tab. 10.13 & 9.8 [MA15]). Paris = « Rue de Charenton/Pont-aux-Choux » factory (Tab. 10.13). Drawing* MARINO MAGGETTI.

Based on the statement « Plusieurs fabriques de faïences fines, établies dans un rayon d'environ 25 lieues de Paris, à Choisy, à Creil, à Chantilly, à Montereau, etc., employant à peu près les mêmes argiles, les mêmes fours, les mêmes procédés » [Several white earthenware factories, established within a radius of approximately 25 leagues from Paris, in Choisy, Creil, Chantilly, Montereau, etc., using approximately the same clays, the same kilns, the same processes] [BR44, II,130-131], the question must be asked to what extent chemical differences can be found between the products of these manufactures. Seven binary correlation diagrams serve this purpose (Fig. 9.21, 9.22). In figure 9.21a, all analyses, with the exception of Sarreguemines, lie on an (imaginary) negative correlation line. Sarreguemines' analysis is also far removed from the rest in the other diagrams. This manufactory therefore used not only different processes (see above), but also different clays than those in the Paris area, as stated by BRONGNIART [BR44, II,141]. According to this author, the white-firing clay comes from another region (Lautersheim in the Palatinate).

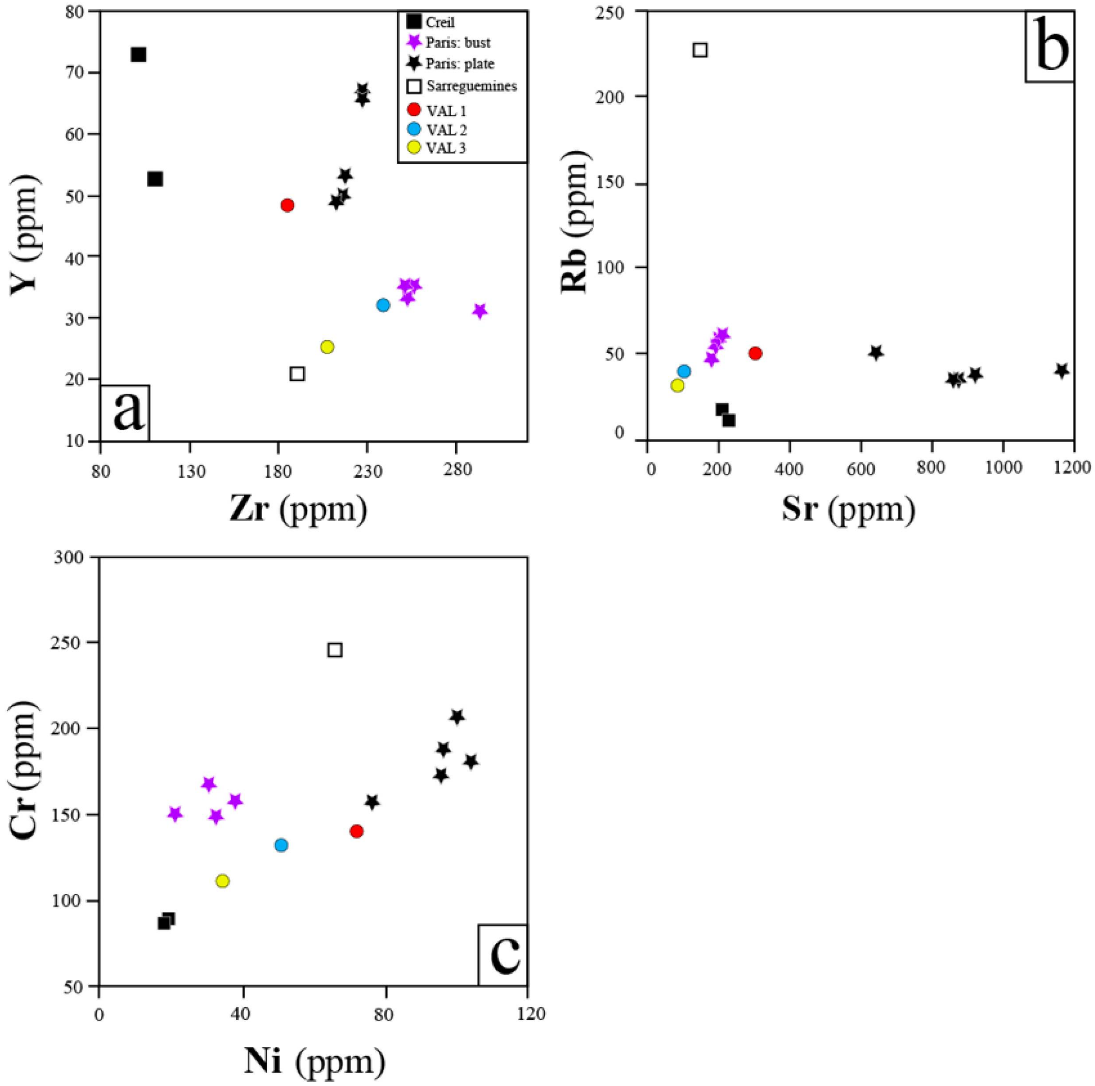

Figure 9.22: *Body (bulk) compositions displayed on bivariate plots of selected elements (Tab. 10.13 & 9.8 [MA15]). Paris = « Rue de Charenton Pont-aux-Choux » factory (Tab. 10.13). Drawing* Marino Maggetti.

Even if the chemical range of both productions cannot be recorded at all for Montereau and Creil with only one (VAL 3) or two (Creil-1, Creil-2) analyses each, a cautious statement can be made, based on the figures 9.21b, 9.21c and 9.22a, that both differ. VAL 1 and VAL 2 are also obviously composed differently than the other samples as shown by their position in these binary diagrams. As for the 18th century « Rue de Charenton/Pont-aux-Choux » samples, conspicuous differences between the older busts and the younger plates can be observed. The former are richer in titanium, magnesium (Fig. 9.21b) and barium (Ba, Fig. 9.21d), but poorer in yttrium (Y, Fig. 9.22a) and nickel (Ni, Fig. 9.22c). The Cr-Ni diagram of figure 9.22c reveals that all analyses, except the « Rue de Charenton/Pont-aux-Choux » busts and the Sarreguemines sample, lie on an (imaginary) positive correlation line. Visibly, the Pont-aux-Choux analyses also show clear differences from the other samples.

Microscopic aspects

Microscopic SEM observation reveals a similar appearance for the three bodies VAL 1, VAL 2 and VAL 3, i.e. large angular to sub-angular non plastic inclusions in a fine felted matrix (Fig. 9.23). These large grains have a chemical composition of 100% SiO_2 and are therefore most likely quartz, given the dominance of this mineral in the diffractograms. The appearance of the surfaces of these grains is either smooth or crenulated. The grains belonging to the first type most probably represent (previously calcined?) ground quartz sand, the grains of the other calcined and then crushed flint. This can be seen very nicely in figure 9.23 (bottom) in the close-ups of VAL 2 (a flint fragment broken down into many microdomains by the thermal treatment) and VAL 3 (a flint and a quartz fragment next to each other). These grains are therefore deliberately added temper. A first difference is immediately visible: the maximum sizes of the non-plastic particles reach 118 µm for VAL 1, roughly similar 111 µm for VAL 2, but only 40 µm for VAL 3. These particle size differences can be explained by different grinding times, the longest being that practiced at Montereau (VAL 3) giving small grains, the shortest being that of VAL 1, giving large grains. Second difference: VAL 2 has the fewest proportion of these grains than the other two samples, which is linked to a highest proportion of the matrix. This results in a ceramic body with lower SiO_2 and higher Al_2O_3 contents than the other two (Tab. 9.8). TBL 2 from Sarreguemines, which is included in figure 9.23 for comparison, has a much finer-grained structure than the other three. It consists mainly of a felty matrix of former clay minerals with some tiny quartz inclusions.

The coexistence of flint and quartz temper in VAL 3 does not entirely agree with the information in an old technical treatise, according to which the ceramic paste was made with a mixture of 87 parts of washed plastic Montereau clay + 13 of pounded flint [BO27]. However, these differences could only reflect different recipes over time, according to which flint and quartz temper was used in early times (VAL 3), and only flint in a more recent production period.

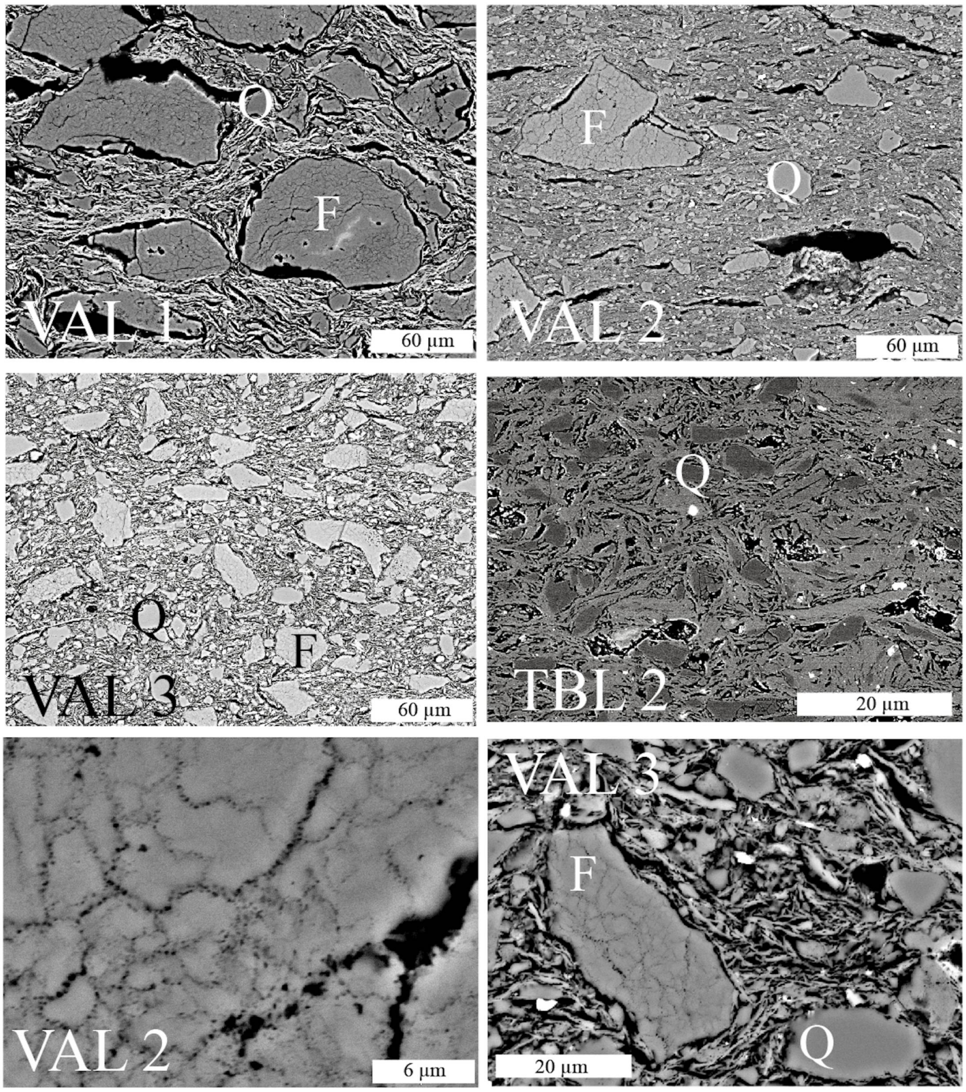

Figure 9.23: *SEM backscattered photomicrographs of the ceramic bodies VAL 1, VAL 2, VAL 3 and TBL 2. Bottom: two clos-ups. F = calcined flint, Q = quartz. Photos* MARINO MAGGETTI.

The chemical composition of the matrix of the three samples does not differ significantly (Tab. 9.9). They consist mainly of alumina and silica and represent former Al- and Si-rich clays, such as those known from the Montereau [MA15, Tab.5] [MA24] or the Westerwald [MA11] deposits. However, they are significantly Al-richer than the published matrix analyses of two Creil dishes. In the SiO_2-Al_2O_3 correlation diagram they lie in the Al-richer section of the (imaginary) negative correlation line (Fig. 9.21a). This must be the case because, according to microscopic analysis, no other ingredient was added other than flint or quartz. One can therefore calculate how much flint or quartz has been added (in wt.%): VAL 1 = 8, VAL 2 = 1.5, VAL 3 = 9. However, such calculations are only approximate estimates because the measured matrix area may not have been representative. Overall, they are significantly lower than the 13, 17 and 27% flint additions in four exemplary mixtures [BR44, II,114].

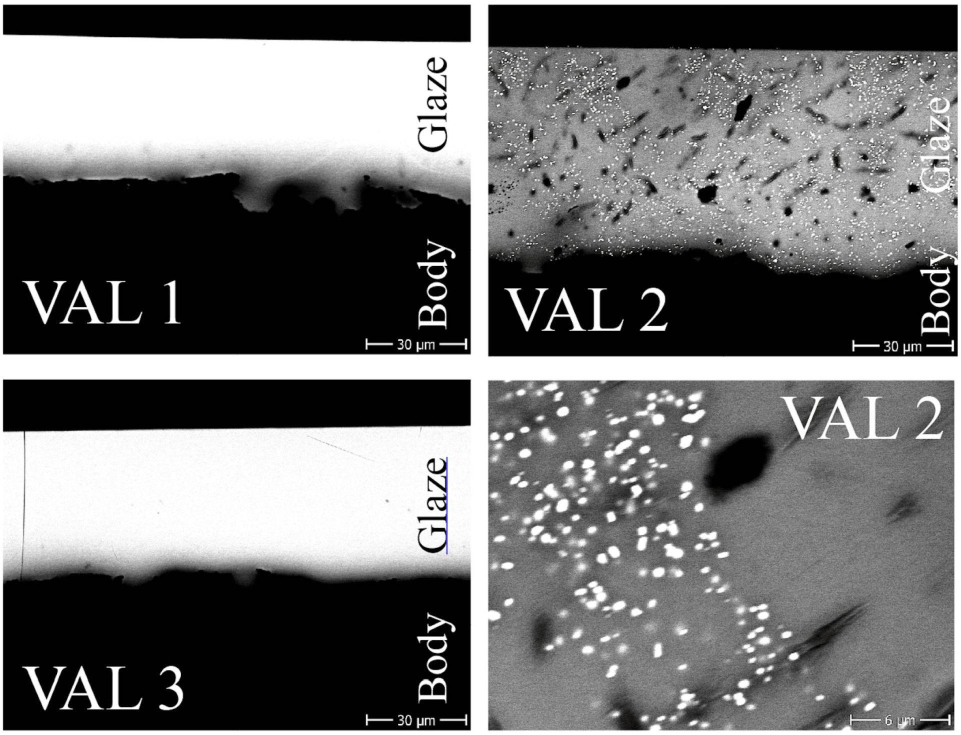

Figure 9.24: *SEM backscattered photomicrographs of the three glazes, with a closer view of VAL 2. Photos* Marino Maggetti.

In conclusion, two results can be drawn from the microscopic and chemical analysis: (1) The morphological appearance is typical of an artificial mixture of two raw materials, one very hard (flint, quartz sand) and one (or more?) very plastic (Al-rich and CaO-poor clay). In 19^{th} century French white earthenware dishes, similar microstructures have so far only been documented in those from the Creil [MA15, Fig.7], Sarreguemines (TBL 2) and the Bordeaux [BE20, Fig.3] [BE21] factories; (2) These differences denote three different recipes for the preparation of the ceramic paste of the analyzed objects VAL 1, VAL 2 and VAL 3. The factories mixed high plastic clays (for VAL 1 and VAL 3 most probably Montereau clay) with crushed flint/quartz in these approximate proportions (wt.%): VAL 1 = 92 + 8, VAL 2 = 98.5 + 1.5, VAL 3 = 91 +9.

Mineralogical composition and inferred maximum firing temperatures

VAL 1 and VAL 3 have the same phase association (in descending order as to quantity): quartz + cristobalite + mullite + rutile + spinel. VAL 2 differs markedly from the other two by the sole presence of quartz with a little rutile and possibly some cristobalite.

The VAL 1 and VAL3 XRD phase association is characterized by high temperature crystals such as cristobalite and mullite, not detected in the SEM analyses. Consequently, these phases are interpreted to occur as minute (sub-µm) crystallites. According to dilatometric studies of MUNIER [MU57, 45-46], flint's chalcedony transforms to quartz and not to cristobalite during the calcination of the flint pebbles. Further, cristobalite cannot be a high temperature reaction product of the flint's Low (α)-quartz since in this one component system temperatures of 1450 °C must be reached [KR30]. Experimental firings of refractory, Fe-poor clays reported mullite formation at temperatures above 950 °C and cristobalite crystallization at temperatures starting at 1050 °C [MA81, MA82]. Such high temperatures are in good agreement with the upper limit of c. 1200 – 1250 °C for the first firing of creamware or « cailloutage » bodies [MU57] [MA18, Tab.1] and were also inferred for the French « Rue de Charenton/Pont-aux-Choux » tableware [MA11].

In the case of VAL 2, significantly lower ancient firing temperatures of below 950 °C can be postulated due to the absence of the high-temperature phases cristobalite and mullite. This agrees well with the higher LOI of VAL 2 (Tab. 9.8). Such temperatures correspond to those that were achieved in a standard faïence kiln, in which also Ca-rich white earthenware could be fired. A different kiln type was needed for the higher fired Al-rich and Ca-poor white earthenware [MA18, Tab.1]. However, such a bottle shaped kiln was not suitable for the traditional Ca-rich white earthenware of the Carouge or « Les Pâquis » white earthenware, as their high Ca content means a high flux amount, resulting in a melting of the tableware above 1000 – 1050 °C. However, it is quite possible that VAL 2 was placed in an area of the bottle kiln where the firing temperatures were lower as 950 °C. In such traditional kilns, experimental firings were able to demonstrate enormous temperature differences depending on the placement of the goods [WO99, WO02]. To clarify this question, more such plates would have to be examined.

Glazes

Microscopic aspects

VAL 1 and VAL 3 show similar maximum glaze thicknesses of approximately 45 µm. In contrast, the glaze of VAL 2 is significantly thicker (Max. 66 µm). VAL 1 and VAL 3 have a homogeneous, inclusion-free glaze, in sharp contrast to the heterogeneous aspect of the VAL 2 glaze (Fig. 9.24). There, areas with numerous tiny and round « white » (under the SEM) crystallites alternate with others in which they are lacking. These crystallites are too small for precise chemical analyses, but according to spot determinations they have very high levels of arsenic (As). The rounded to elongated and much larger «

black » (under the SEM) crystals are a SiO_2 phase, probably quartz. Another type of « black to greyish » crystals can be observed in the form of small rods. They consist only of carbon (graphite?).

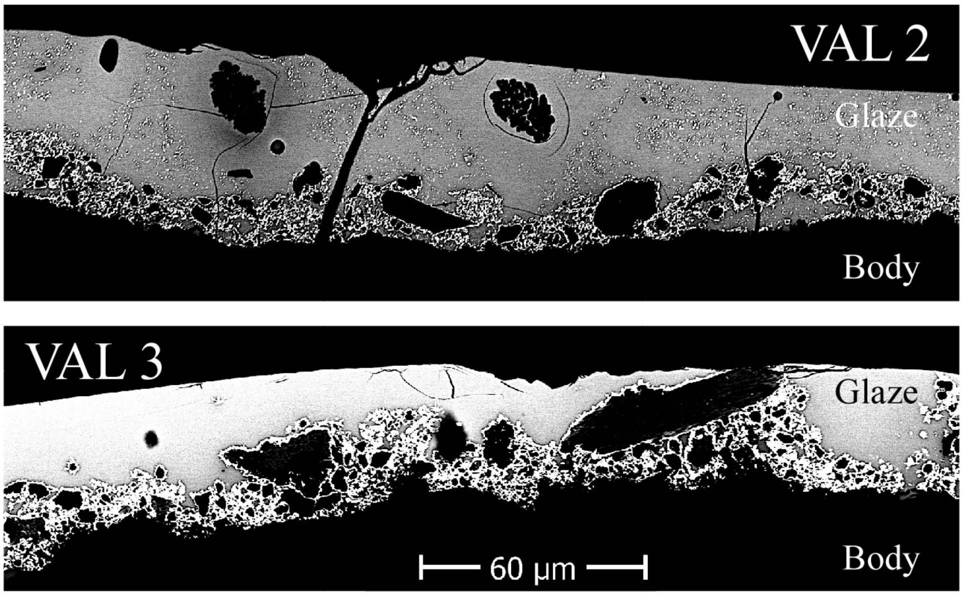

Figure 9.25: *SEM backscattered photomicrograph of a vertical cut through a black line of the transfer printing decoration of VAL 2 and VAL 3. Same scale for both images. Photos MARINO MAGGETTI.*

In some parts of the VAL 2 glaze, several clusters of such small roundish « black » grains, surrounded by a zone in which the « white » As-bearing crystallites are missing, can be observed (Fig. 9.25). According to chemical microanalyses, these clustered grains consist only of SiO_2, while the inclusion-free glaze zones have significantly higher SiO_2 contents than the inclusion-rich glaze. This can only mean that the clusters represent formerly large quartzes that were only partially melted during the glaze firing and appear as a heap of smaller grains after cooling. On the other hand, the locally produced SiO_2 melt mixed only partially with the liquid Pb-rich glaze, since such SiO_2-rich melts are significantly higher viscous than the Pb-melts. This behavior explains why the SiO_2 melt solidified into an inclusion-free glass when it cooled. Rounded cracks can be observed around some clusters. They arise during cooling as a result of the volume changes (contraction) at the transition from High (β) to Low (α) quartz at 573 °C.

The contact with the ceramic body is sharp, with rare, in these cases very thin, reaction zones. As expected, this shows that the three liquid glaze suspensions were applied to bisque fired plates, i.e. that had already been fired.

Microchemical analysis

Table 9.10 shows the results of the microchemical analyses using SEM-EDS. In this context, it should be noted that the analytical method used cannot detect boron. Several standard ceramic books from the early 19th century document the addition of borax ($Na_2O.2B_2O_3.10H_2O$) or boric acid ($B_2O_3.3H_2O$) in the glaze recipes [OP07, BR44]. This chemical element became extremely important in 19th century ceramic factories, as it caused, among other benefits, a significant increase in the glaze's hardness [SAL57, BE21, BEAA21]. As an example, white earthenware glazes from the JOHNSTON-VIEILLARD & CO. manufactory (Bordeaux, France), produced between 1835 and 1895, contain 2.5-10 wt.% boron oxide (B_2O_3) [BE21, BEAA21]. That a transparent lead glaze was soft, easily corroded and prone to cracking was by the 18th century a well-known fact [BO27]. To avoid this defect, some manufacturers covered their ceramic bodies with a classic tin opacified glaze like that used for faïences [BR44, II,132]. Analyses of this glaze type on white earthenwares were carried out for the Bois d'Épense [MA07], Lunéville [MA11], Niderviller [MA11] and Saint-Clément [MA11, MA20, MA23] manufactories.

Leaving aside boron, the glazes VAL 1, VAL 2 and VAL 3 are chemically quite similar. The VAL 1 glaze stands out from the other two by a certain quantity of copper (Cu), and the VAL 2 glaze with its content of 0.4% arsenic oxide (As_2O_3), a fact which corresponds well to the microscopic observations described above. The chlorine content (Cl) shows that rock salt (NaCl) was used in the glaze's production. From the SO_3 content it can also be concluded that the recipe contained a small proportion of sulfate, probably in the form of gypsum, as in « Les Pâquis » since summer 1791 [SI95, 50-51]. The K_2O content of all three glazes is significantly higher than in those from Creil and Sarreguemines. Potash, an impure K-carbonate obtained through the combustion of wood, was therefore also added to the raw glaze mixture, just as the « Les Pâquis » factory did [SI95, 58]. The recipe for the three raw glazes must therefore have been close to that of EXCHAQUET for the « Les Pâquis » glaze, namely litharge + potash + sand [SI95, 53]. But Montereau also used a similar recipe: minium + potash + calcined flint [OP07]. The three glazes have the same iron content (0.2 wt.% Fe_2O_3), which is very close to the Fe detection limit. The different shades of yellow visible macroscopically must therefore be due to minor concentration deviations that cannot be recorded with this analytical method.

Compared to the plates from Creil and Sarreguemines (Tab. 9.10), the three VAL glazes are significantly richer in potassium. However, in Creil-2, the silica content is higher and the PbO content is lower. The Sarreguemines plate TBL 2 stands out due to its high Al_2O_3 content. As for the older glazes from the « Rue de Charenton/Pont-aux-Choux » factory (Tab. 10.14), the three VA glazes do not match those of the busts at all and only to a limited extent those of the plates, as their Na_2O content is significantly lower. The glazes of the Bordeaux manufactories Johnston & Co. (c. 1840, a, mean of 10 analyses) and Vieillard & Co. (c. 1845, b, mean of 15 analyses) have a completely different chemical composition [BE21, BEAA21, Tab.1]: SiO_2 57.8 wt.% (a) and 57.1 wt. % (b), PbO 14.5 wt. % (a) and 12.1 wt. % (b), Na_2O 2.28 wt. % (a) and 1.79 wt. % (b), Al_2O_3 9.37 wt. % (a) and 13.3 wt. % (b), K_2O 1.7 wt. % (a) and 3.75 wt. % (b), CaO 5.68 wt. % (a) and 4.79 wt. % (b), P_2O_5 0.38 wt. % (a) and 0.29 wt. % (b). Based on this, the authors calculated two Bordeaux glaze recipes composed of sand or flint + kaolin + orthoclase + calcium carbonate + lead oxide + boric acid + sodium carbonate [BE21, BEAA21, Tab.2]. The proportions were: Sand or flint 37.1 wt. % (a) and 27.1 wt. % (b), kaolin 18.6 wt. % (a) and 25.1 wt. % (b), orthoclase 8.4 wt. % (a) and 17.0 wt. % (b), calcium carbonate 9.3 wt. % (a) and 8.6 wt. % (b), lead oxide 10.6 wt. % (a) and 10.2 wt. % (b), boric acid 12.4 wt. % (a) and 9.2 wt. % (b) as well as sodium carbonate 3.6 wt. % (a) and 2.8 wt. % (b).

As for VAL 1, a measurement of the glaze near the contact with the ceramic body confirms that it has exchanged chemical elements with it. Here, the glaze is much richer in alumina (Al_2O_3), silica (SiO_2) and potash (K_2O) than the more external part. A lead diffusion from the glaze into the ceramic body also explains why the glaze there is clearly less rich in Pb than the external part. A lead contamination of the ceramic bodies has already been highlighted by the XRF results (Tab. 9.8). Such diffusion processes certainly also took place for VAL 2 and VAL 3.

Black underglaze transfer printing decoration

Macroscopic aspects

The decors of VAL 2 and VAL 3 show everywhere a homogeneous dark black coloration. For VAL 1 this only applies to the lines, while the central image with the « Palais de Luxembourg » is in brown-black and the flower garlands in black-brown tones.

Microscopic aspects

In what follows, the discussion will only focus on the outer black lines of the decoration, the other elements of it having not been analyzed so as not to damage the dishes too much. Based on the fact that the colours seem to be the same everywhere, we can assume that there are no differences in pigments, for a single plate, between the black lines and the other elements of the transfer printing decoration.

The black lines are located at the boundary between the ceramic body and the glaze, which is typical for underglaze decorations (Fig. 25, 26). They can extend far into the glaze and even reach its surface. The contact with

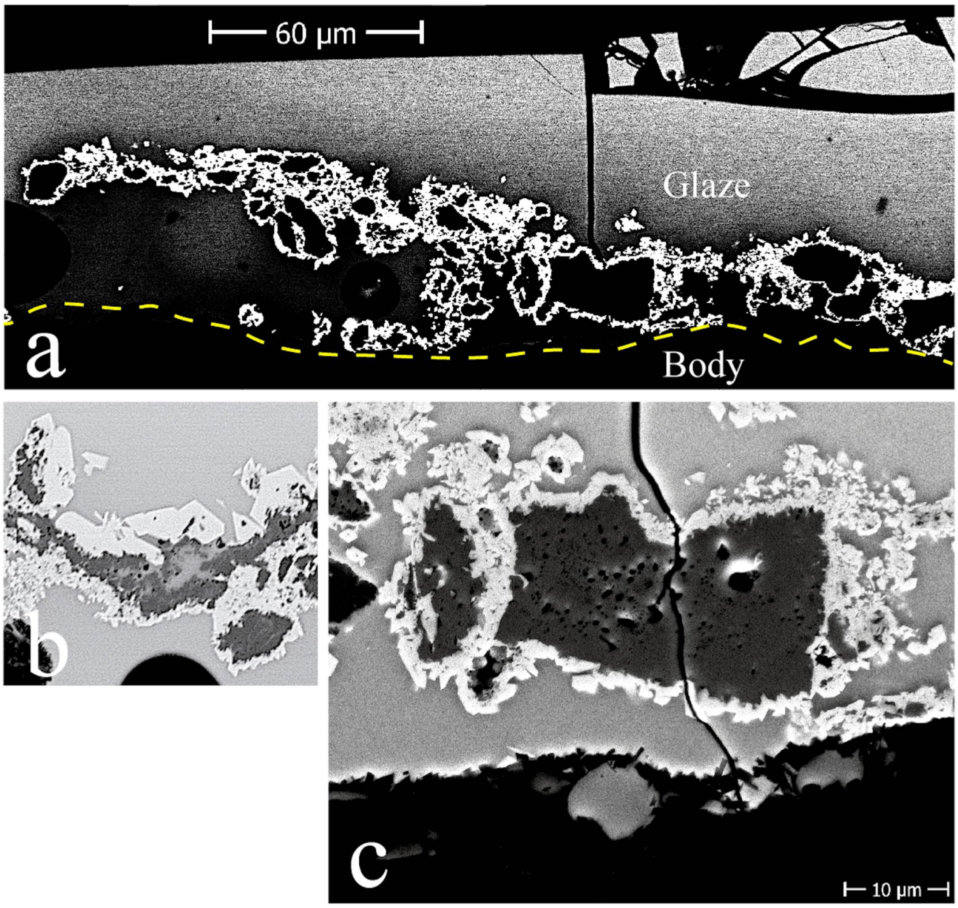

Figure 9.26: *VAL 1: SEM backscattered (a, b) and secondary electronic (c) photomicrograph of a vertical cut through a black line of the transfer printing decoration. (a) The yellow dashed line marks the upper limit of the body. (b) Image width:* 50 µm. *Photos Marino Maggetti.*

the glaze is sharp. Only a very thin reaction zone is visible at the contact to the ceramic body. The measured maximum thicknesses of the black lines are almost identical, namely 29 µm for VAL 1, 27 µm for VAL 2 and 29 µm for VAL 3. The thickness of the original black paint layer on the now burned away paper support was therefore the same for all three plates. While in VAL 2 and VAL 3 the black line is directly adjacent to the contact with the body over the entire length, in VAL 1 this is only the case in a few places (Fig. 9.26). Relict pigment fragments at the contact point to the fact that the transfer print was originally applied to the ceramic body. Such a detachment of the pigment layer from the body is probably a technical error, the causes of which are not fully understood. Does this have something to do with the (paper?) support on which the black decoration was applied? Was it very thick and gave the liquid glaze the opportunity to penetrate between the body and the paint layer during the glaze firing?

In cross sections, the black lines of the three plates consist of large isolated « black to greyish » (under the SEM) grains, with irregular contours, always surrounded by a corona of small « white » (under the SEM) crystals, often shaped like spears (Fig. 9.25, 9.26). The maximum length of the former particles is about 50 µm for VAL 1, 30 µm for VAL 2 and 58 µm for VAL 3. Their morphologic aspect is either spongy-holey or smooth (Fig. 9.27, 9.28). Close-up images show that the spongy internal structures consist of a heap of tiny crystals, in contrast to those with a homogeneous, smooth surface, which are therefore likely to be single crystals. Judging by the splintery, angular outlines, these « black to greyish » crystals must be the primary pigments that were used as ground powder for the transfer printing decoration. Their irregular and jagged outlines show a strong reaction with the liquid glaze during the firing, i. e. a progressing dissolution from the contact inwards. The « white » micro-crystals are a maximum of 11 µm in size and show very few inclusions. At the point of contact with the glaze they show idiomorphic outlines (Fig. 9.26b), a sign that they were in equilibrium with it and crystallized from it.

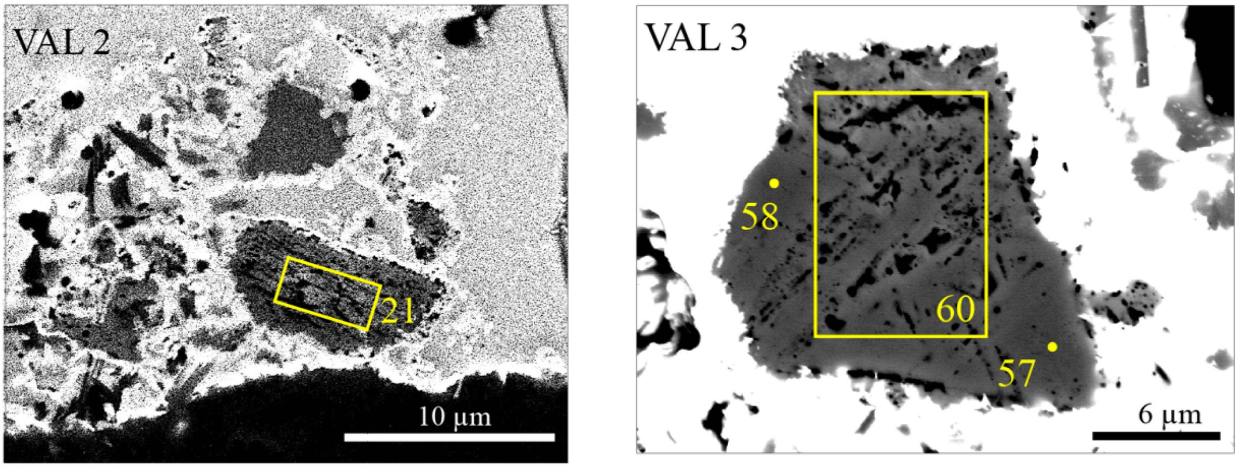

Figure 9.27: *SEM backscattered photomicrographs of a selected Mn (above, VAL 2) and Fe (below, VAL 3) black pigment. In yellow the points (not to scale), the surface analyzed and the numbering of the analysis (Tab. 9.11). The porous morphology of both pigments is clearly visible. Photos and graphic design* MARINO MAGGETTI.

Microchemical analysis

A quantitative chemical analysis of the black decoration is not possible because of the inhomogeneous distribution of the pigment particles and the low thickness of the black. However, the chemical composition of the chromophores shows that it is overall an iron-manganese black (Table 9.11).

The chemical analysis of the « black to greyish » particles (Tab. 9.11) cannot

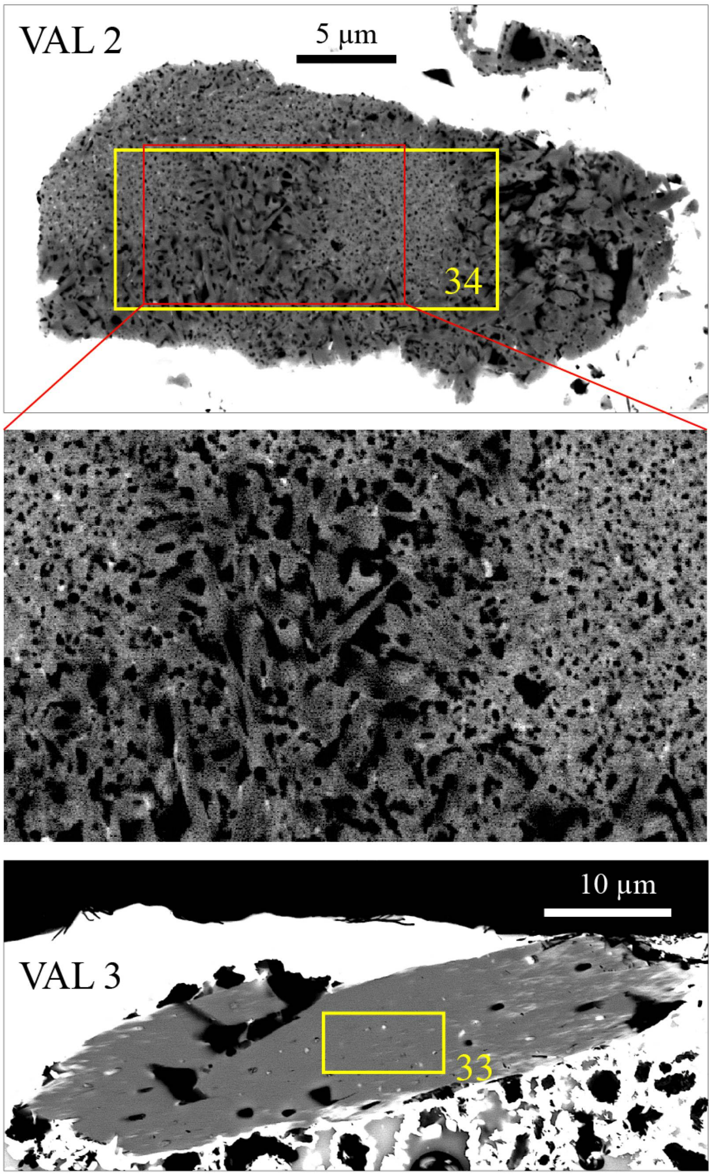

Figure 9.28: *SEM backscattered photomicrographs of two selected barium-rich Mn black pigments. In yellow the surface analyzed and the numbering of the analysis (Tab. 9.10). Photos and graphic design* Marino Maggetti.

give precise results, on the one hand, due to their spongy, porous morphology, whose holes are filled by a glassy phase and whose composition was therefore included in the analytical results, and on the other hand, because the thickness of many of these particles is probably below the diameter of the electron beam. For these reasons the results must be interpreted with caution. If the chemical components of the glaze are not taken into account, only a few remain that can be assigned to these particles, namely Mn, Fe, Co, Cu and Ba. Given this assumption, four particle types can be distinguished (Tab. 9.11): Type I, iron-rich with little or no manganese. Some cobalt (Co) may be present;

Type II, with dominant manganese, very little Fe and a significant amount of copper (Cu); Type III, with iron and manganese in varying proportions, along with few copper, and type IV, rich in manganese and barium (Ba). As for the internal micromorphology, the type I particles are always homogeneously smooth, while the other types are either spongy porous (the majority) or homogeneously smooth.

Without micro-X-ray diffraction or micro-Raman spectroscopy, one can only speculate about the crystallographic nature of the four types. Taking into account that the firing in the kiln took place under oxidizing conditions, the particles should be present as oxides. Type I would then be hematite (Fe_2O_3), type II a Mn oxide, type III a FeMn oxide and type IV a barium-rich Mn oxide. Types I to III occur in all three samples. Type IV is missing in VAL 1. The type IV pigments differ in their morphological appearance depending on the sample. In VAL 2 they are porous and, when magnified, show an agglomeration of micro-crystals. Contrasting, the Val 3 pigments are homogeneously smooth in the central areas and only a little frayed at the edges.

The « white » crystals are, as shown by their chemical compositions (Tab. 9.12), members of the kentrolite-melanotekite series, with notable variations in their iron (Fe) and manganese (Mn) contents. The orthorhombic endmembers kentrolite and melanotekite have the formula $Pb_2Mn_2^{3+}(Si_2O_7)O_2$, respectively $Pb_2Fe_2^{3+}(Si_2O_7)O_2$. Both were widely reported from brown and black decorations of lead glazed ancient ceramics, as examples: for kentrolite [MA21] and for melanotekite [FE17a, FE17b, FE19, MOL13, MOL18, MOL20, KL23]. In all three samples, the overwhelmingly idiomorphic shape of the melanotekites surrounding the « black » particles is a strong argument that they were in equilibrium with the surrounding liquid glaze and that they crystallized during cooling from it. The endmember kentrolite forms at temperatures of 650 °C and remains stable at least at 840 °C [MOL13]. The other endmember melanotekite dissolves completely at firing temperatures above 950 °C and crystallizes again during cooling [FE17b, KL23]. The chemical elements necessary to form kentrolite-melanotekite are given by the reaction of the melted raw glaze with the primary « black to greyish » pigments. One would therefore expect a correlation between the chemical composition of the pigments and the kentrolite-melanotekite crystals surrounding them. However, such a correlation could not be found. It must be concluded that during firing the locally formed heterogeneous melts around the « black to greyish pigments » quickly homogenized. This is not surprising, because the viscosity of this Pb melt must have been very low with the additional Fe, a potent flux, from the dissolved primary pigments.

The glassy area in which the pigment crystals are located only differs from the glaze above in a slightly higher CaO-, Mn_2O_3- and Fe_2O_3- content (Tab. 9.10).

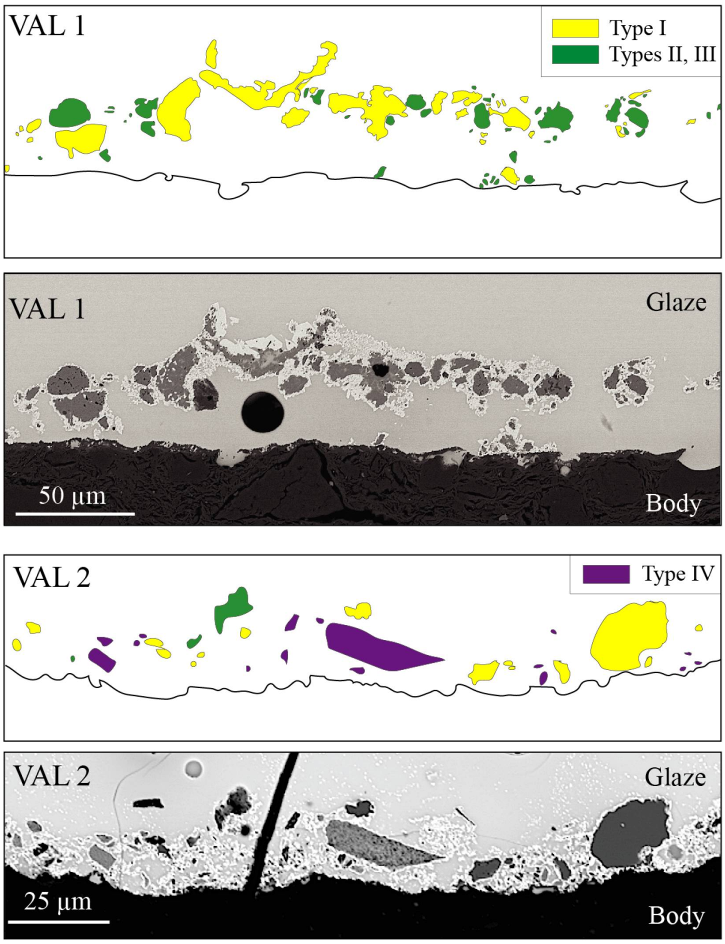

Figure 9.29: *VAL 1, VAL 2: SEM backscattered photomicrographs and corresponding schematic drawings of the transfer printing decoration with the various black pigments. The surrounding kentrolite-melanotekite crystals have been omitted for clarity. The large Ba-containing crystal was analyzed (VAL 2-29; Tab. 9.11). Photos and drawings* Marino Maggetti.

A low BaO content could exceptionally be measured in the vicinity of a large type IV pigment. Oxides typical of the VAL 1 glaze, such as TiO_2 and CuO, or As_2O_3 for VAL 2, could also be found in these glassy areas, a sign that the original black pigment decorations were not a crystal frit, i.e. a mixture of crystals and glass, but a blend of crystalline substances without interstitial glass? But the possibility cannot be ruled out that the glassy parts of the original pigment frit could have reacted with the glaze mixture during the glaze firing, dissolved into it and took over some of their chemical components.

Mappings

In this section only the large, « black to greyish » pigment grains will be discussed, without the secondary small crystals of the kentrolite-melanotekite series formed during cooling. Secondly, only the most important primary pigments in terms of size were included in the schematic drawings. In these, types II and III were combined, since different brightnesses in the Mn map could be due not only to different Mn (and correlated Fe) contents, but also to over- or underlying glaze portions. And thirdly, only colouring chemical elements whose content in the pigment grains is above 5 wt. % were taken into account.

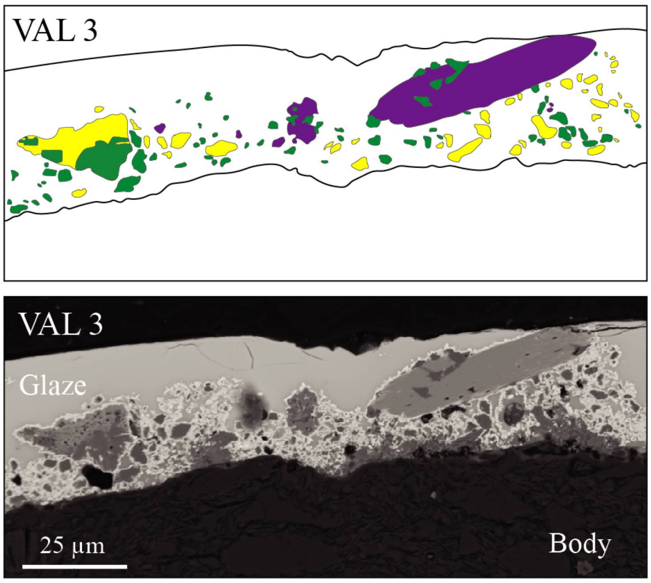

Figure 9.30: *VAL 3: SEM backscattered photomicrographs and corresponding schematic drawings of the transfer printing decoration with the various black pigments. The surrounding kentrolite-melanotekite crystals have been omitted for clarity. The large Ba-containing crystal was analyzed (VAL 3-53; Tab. 9.11, Fig. 9.28). Photos and drawings* Marino Maggetti.

The electron microscope image for VAL 1 shows very nicely how the pigments of the black decoration « float » in the glaze (Fig. 9.29). The shape of the « black to greyish » pigment grains is irregular and ranges from rounded to bizarre outlines. In this Black, type I (hematite) dominates in quantity. The VAL 2 Black differs significantly from the previous one (Fig. 9.29). Overall, it has significantly fewer primary pigments, contains Ba-rich type IV, type I is no longer as dominant and the black decoration lies entirely on the ceramic body. In the VAL 3 Black, the four pigment types are more common than in VAL 2, with a slight quantitative dominance of type IV (Fig. 9.30).

Original recipe of the black pigment layer

This work is the first scientific study of the black transfer print decoration of three French white earthenware from the early 19th century. For this reason, there are no published results with which the findings can be compared. The black layer is a complex mixture of different black chromophores that were obtained synthetically. The raw materials were most likely iron- and manganese-rich earths, which were fritted and used as ground powder. The Ba content of Pigment IV could provide an indication of the origin of these earths. But it could also be the residue of a barium carbonate addition, in order to precipitate the soluble salts that could have been in the Fe- and Mn-rich raw materials, and that would have crystallized out on the surface during drying without such an admixture [DIG24]. The elements cobalt and copper were mixed in to deepen the colour. Both are well-known chromophores and were detected, for example, in the inglaze black of a tiled stove dated 1768/1770 [MA22, Tab.3].

The results show that there are three different black recipes. Overall, an iron- and manganese-rich recipe is inferred from the chemical composition. Such a recipe differs from that of MÉRY (1814). However, as with MÉRY's recipe, copper and cobalt must have been used in the black recipes of VAL 2 and VAL 3. Barium is missing from MÉRY's patent, but is a characteristic of both VAL 2 and VAL 3 recipes.

Concluding remarks

The analyses and the discussion have shown that the three plates classify as Al-rich and Ca-poor white earthenwares. All three ceramic bodies were made from a mixture of highly plastic Al-rich clay and calcined, ground flint and quartz. But they differ in their chemical and mineralogical composition as well as in their microstructure. VAL 1 has a white, the other two a creamy body. This correlates well with a lower Fe_2O_3 content in VAL 1. VAL 2 has the lowest temper content, which is reflected in a significantly lower SiO_2 concentration than VAL 1 and VAL 3. The VAL 3 temper grains, with their maximum diameter of 40 µm, are significantly smaller than those in the other two bodies (110-120 µm), a sign that they have been ground longer. From the mineralogical body composition can be concluded that VAL 2 was fired at significantly lower temperatures of 950 °C than the other two plates (at least 1050 °C). This is confirmed by a higher ignition loss.

The glaze of VAL 2 differs from the other two in its higher maximum thickness of 66 µm versus 45 µm. Both others are virtually inclusion-free, apart from a few quartz relics, while VAL 2 contains abundant arsenic-rich microcrystallites.

The black transfer print decoration has the same thickness of approx. 27-29 µm on all three plates. It contains primary colouring pigments in the form of ground grains of types I (Fe), II (Cu-bearing Mn), III (Fe, Mn) and IV (Ba-bearing Mn). Type IV is missing in VAL 1. All types are lined with small kentrolite-melanotekite crystals, which were formed during the glaze firing, most likely during the cooling phase. In summary, the three plates reflect different technical processes, respectively three different recipes. On the one hand, this could indicate an origin from three different manufactories or, on the other hand, different technologies used in a single manufactory.

To the question of whether VAL 2 comes from the French « Geneva-La Balme » or Aumale manufactories, the analyses can provide a first answer. The fashion for the Swiss hero William Tell began to spread in France from 1793-1794 (Revolutionary section W. TELL in Paris, name of a warship, engravings etc...). To our (VN) actual knowledge, there were probably two distinct series of « William Tell » decorations: (1) 1st period (1791 – 1796). Legends without numbers, and on some plates with glazes applied with a brush; (2) 2nd period (1797-1805?). Legends with numbers, perfect glazes, but some on a body showing iron particles. These decorations could be dated after the relocation of the factory to La Balme. This hypothesis is supported by the fact that in some of these new numbered legends the names of « MELCTAL », « GEMMI » and « CLAIRE » appear, which come from CLARIS DE FLORIAN's novel published from 1798/99. It would be more than interesting to be able to study a complete numbered series. 1st period « William Tell » could have been used in « Les Pâquis » until the closure in 1796. On the other hand, it could be possible that a stock of unglazed, only bisque fired goods could have been brought to la Balme, where they were then covered and glazed with the « William Tell » transfer print decoration in the early years of the 19^{th} century. According to the « Les Pâquis » recipes, documented in the archives, these unglazed objects should have a Ca-rich composition. But this is not the case at all for the Ca-poor and Al-rich VAL 2 plate. Or were the early experiments of PIERRE VERNI DE VILLARS crowned with success in later years, or in 1792 with the arrival of the English team from France, both not recorded in the archives? In this case, Al-rich and Ca-poor unglazed dishes could certainly easily have been brought to « Geneva-la Balme ». On the other hand, it should be noted that EXCHAQUET's recipe only mentions regional Morez sand, but no flint. But the temper of VAL 2 is rich in flint fragments, which would be coherent with the knowledge own by WOOD and his team. This could speak against such a hypothesis. Unfortunately, no records are known as to which recipes were used in the « Geneva-la Balme » factory for the newly manufactured white earthenware. The traditional ones from « Les Pâquis » or new blends? It seems most probable that the same Ca-rich mixtures as in « Les Pâquis » should have been used there, at least at the beginnings. Later on, BINET could have turned to new paste blends low in Ca. For all these reasons it cannot be decided whether VAL 2 was produced in this factory with a « recycled » bisque fired plate from « Les Pâquis » or with a new « Geneva-la Balme » ceramic paste. This would require more archival evidence and/or more analyses of plates with unquestionable « Geneva-La Balme » origins.

Finally, the lack of agreement with the plate assigned to Aumale (VAL 1) can be seen as an argument that the « William Tell » plate VAL 2 was most probably not created in this factory, at least not using the technical processes recorded in VAL 2. Of course, this provisional statement would have to be substantiated by a larger number of comparative analyses.

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Author contributions

MM wrote chapters 1-2, 4-6. PV provided the three plates (VAL 1, VAL 2, VAL 3) and wrote chapter 3 in French, translated by MM in English. Then, PV did the checking and correction of chapter 3. Both read and approved the final manuscript.

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	BUSTS				Repository Pont-aux-Choux (2011)				
An. No.	**BUS 1**	**BUS 2**	**BUS 3**	**BUS 4**	**TBL 9**	**TBL 18**	**TBL 30**	**TBL 31**	**TBL 32**
SiO_2	69.34	67.64	67.59	67.50	60.72	63.29	61.97	61.68	61.30
TiO_2	1.25	1.23	1.25	1.24	0.74	0.92	0.74	0.74	0.75
Al_2O_3	25.97	27.10	27.80	27.85	33.97	31.49	33.83	33.88	34.02
Fe_2O_3	1.29	1.13	1.10	1.23	1.26	1.18	1.17	1.17	1.29
MnO	0.01	0.00	0.01	0.03	0.01	0.12	0.03	0.02	0.03
MgO	0.20	0.22	0.24	0.24	0.62	0.65	0.72	0.75	0.57
CaO	0.60	0.62	0.60	0.63	0.84	0.94	0.83	0.84	0.85
Na_2O	0.18	0.19	0.19	0.18	0.72	0.75	0.76	0.73	0.61
K_2O	0.65	0.78	0.80	0.81	0.72	0.75	0.76	0.73	0.61
P_2O_5	0.09	0.10	0.10	0.10	0.71	0.35	0.51	0.51	0.51
Ba	117	120	120	144	354	261	302	319	322
Cr	167	152	148	159	208	157	188	174	180
Cu	29	13	18	17	2	11	10	7	12
Nb	24	24	23	23	17	23	17	17	18
Ni	30	22	33	38	100	76	96	96	104
Pb	108	184	146	159	654	2401	1799	861	956
Rb	47	55	61	61	41	52	34	35	38
Sr	180	194	209	212	1156	642	858	870	925
V	120	108	110	120	n. d.	n. d.	n. d.	n. d.	n. d.
Y	31	33	35	35	65	67	50	49	53
Zn	88	77	76	74	73	153	79	75	106
Zr	293	252	252	256	228	227	216	212	217
Sum	99.70	99.13	99.81	99.95	99.89	100.11	100.96	100.64	100.27
LOI	0.57	0.88	0.31	0.32	0.41	0.45	0.42	0.33	0.29

Table 9.4: *Chemical composition (X-ray fluorescence) of the ceramic bodies of four samples of busts (BUS) and five dishes (TBL). Oxides, Total and loss on ignition (LOI) in wt. %, trace elements in ppm. n.d. = not determined.*

An. No.	**BUS 1**	**BUS 2**	**BUS 3**	**BUS 4**	**TBL 18**	**TBL 32**
Surface analysed (µm)	750 x 60 µm	120 x 60 µm	200 x 50 µm	100 x 50 µm		
Na_2O	1.3	1.5	1.2	1.4	2.4	1.5
MgO	0.6	0.4	0.5	0.6	0.1	0.3
Al_2O_3	3.5	3.5	3.7	4.6	3.4	3.5
SiO_2	45.7	37.8	46.7	48.7	32.6	39.1
P_2O_5	0.8	0.8	0.9	0.9	0.1	0.3
Cl					0.1	
K_2O	7.4	4.9	5.5	6.6	1.1	2.2
CaO	3.0	2.7	3.0	2.6	1.4	2.3
TiO_2					0.1	
Fe_2O_3	0.4	0.3	0.4	0.5	0.5	0.6
PbO	37.3	48.1	38.1	34.1	57.3	50.2
ZnO					0.9	
Sum	100.0	100.0	100.0	100.0	100.0	100.0

Table 9.5: *SEM-EDS analytical results of the glazes of four busts (BUS 1-4) and two plates (TBL 18, 32) from the Paris manufacture « Rue de Charenton/Pont-aux-Choux ».*

			Body				Glaze		Ref.
			Type		Frit				
Date	Attribution	An. No.	Al	Ca	Pb	Alc	Pb	Pb - Sn	
1749-1788	Rue de Charenton / Pont-aux-Choux	BUS 1-4, TBL 18, 35	x				x		a, b
1755-1760	Saint-Clément	TBL 15		x	x			(x)	a, c
c. 1770	Niderviller	TBL 3		x				x	a, c
""	Saint-Clément	TBL 4		x	[x]			(x)	a, c
""	Saint-Clément	TBL 20		x	x			x	a, c
""	Saint-Clément	TBL 21		x	x			x	a, c
""	Saint-Clément	TBL 23		x	x			x	a, c
c. 1780	Lunéville	LNV 14		x	[x]			(x)	a, c
""	Lunéville	LNV 15		x	[x]			(x)	a, c
Late 18th	Bois d'Épense	TBL 13		x	[x]		(x)	(x)	a, c
""	[Lorraine ?]	TBL 11		x			(x)		a, c
""	[Lorraine ?]	TBL 12		x	[x]				a, c
""	Lunéville	TBL 1		x	[x]		(x)		a, c
""	Lunéville	TBL 6		x				(x)	a, c
""	Lunéville	TBL 10		x			(x)		a, c
""	Saint-Clément	LNV 35		x	x			x	e
""	Saint-Clément	TBL 16		x	[x]			(x)	a, c
""	Saint-Clément	TBL 19		x	[x]		(x)		a, c
""	Saint-Clément	TBL 33		x	[x]		(x)		a, c
18th	Saint-Clément	TBL 22		x	x			x	a, c
1793-1832	**Niderviller**	Nider-1		x			x		d
1797-1832	**Creil**	Creil-1	x				(x)		d
""	**Creil**	Creil-2	x				x		d
Early 19th	Saint-Clément	BEI 174		x	[x]			x	f
c. 1820	Sarreguemines	TBL 2	x				x		a, c
c. 1830-c. 1885	**Bordeaux**		x				x		g, h

Table 9.6: *Summary of the French white earthenwares dishes analyzed so far. Bold = impressed trademark, unglazed production waste (« biscuit »). Frit Pb: [x] = inferred from the Pb content higher than 9'000 ppm. Glaze: (x) = macroscopical evidence. Reference: (a) [MA11]; (b) [MA24]; (c) [RO12]; (d) [MA15]; (e) [MA20]; (f) [MA23]; (g) (h) [BE20, BEAA21].*

No. An.	Attribution	Date	Description	Sample weight after cleaning (g)
VAL 1	Aumale ?	1824/25 - 1831	Round flat plate. Diam: 21,2 cm; H: 1,6-2,0 cm. Yellowish transparent glaze, smooth and heavely cracked on the back. Underglaze black printed decoration: in the centre a vignette of the Palais de Luxembourg at Paris with the inscription « PALAIS DU LUXEMBOURG / Chambre des Pairs », bordered by a painted fine black line; on the rim six floral motifs, bordered by two painted black lines.	7.6
VAL 2	Geneva - La Balme ?	1797 - 1810 (?)	Round flat plate. Diam: 24,0 cm; H: 2,0-2,1 cm. Slightly yellowish transparent glaze with radiating lines on the back. Underglaze black printed decoration: in the centre three adults and two children under a tree in a mountainous landscape with the inscription « Melctal raconte pourquoi son fils a dû se sauver »; on the rim six floral motifs with a rose in the center, bordered by two painted black lines.	7.2
VAL 3	Montereau	1800-1815	Round flat plate. Diam: 21,5 cm; H: 2,3-2,5 cm. Transparent and smooth glaze. Stamped mark « MONTEREAU » (L: 2.2 cm; H: 0.2 cm). Underglaze black printed decoration: in the centre a vignette of the « Jardin des Plantes » museum with the inscription « MUSÉE DU JARDIN DES PLANTES A PARIS », bordered by a painted black net; on the rim a circular branch with oak leaves and acorns after two leaves (in alternating outward or inward orientation), bordered by two black painted nets, the outer one a little thicker than the inner one.	5.1

Table 9.7: *Sample list.*

Oxyde / Element	**VAL 1**	**VAL 2**	**VAL 3**	**CREIL-1**	**CREIL-2**	**TBL 2**
SiO_2	74.67	70.03	74.61	79.37	77.02	61.14
TiO_2	0.96	1.27	1.08	0.59	0.62	1.06
Al_2O_3	20.93	24.67	20.45	17.02	19.18	29.95
Fe_2O_3	0.77	1.23	1.02	0.65	0.71	1.43
MnO	0.01	0.01	0.01	0.00	0.00	0.01
MgO	0.21	0.25	0.22	0.08	0.10	0.52
CaO	0.49	0.69	0.80	0.40	0.40	0.38
Na_2O	0.14	0.30	0.17	0.29	0.19	1.95
K_2O	0.76	0.68	0.51	0.34	0.37	3.60
P_2O_5	0.14	0.06	0.06	0.13	0.12	0.10
Ba	252	184	84	128	132	646
Cr	140	133	111	87	90	246
Cu	20	27	20	10	10	33
Nb	18	31	26	17	17	20
Ni	72	51	34	18	19	66
Pb	737	289	447	1744	3764	503
Rb	51	40	32	17	11	229
Sr	303	97	83	211	227	148
Y	48	32	25	73	53	21
V	111	192	159			
Zn	23	32	22	16	16	46
Zr	185	239	208	101	110	191
Sum	99.28	99.33	99.05	99.17	99.15	100.36
LOI	0.47	2.84	0.76	0.40	0.67	4.25
Provenience	Aumale ?	Geneva - La Balme ?	Montereau, marked	Creil, marked		Sarreguemines, marked
Dating	1824/25 - 1831	1797-1810 ?	1800-1815	1797-1832		c. 1820
Literature				[MA15]		[MA11]

Table 9.8: *XRF analytical results of the analysed plates and three from other factories. Oxides, total and loss on ignition (LOI) in wt. %, trace elements in ppm.*

An. No.	VAL 1	VAL 2	VAL 3	Creil-1	Creil-2
Surface analysed (µm)	60 x 70	120 x 110	25 x 25	20 x 20	20 x 20
Na_2O	0.2	0.2	0.6		
MgO					
Al_2O_3	29.3	26.9	30.4	26.5	27.8
SiO_2	66.7	68.5	65.7	67.4	67.9
SO_3			1.3		
Cl_2O		0.1			
K_2O	0.7	0.8		1.6	0.8
CaO	0.8	1.2	0.1	0.8	0.7
TiO_2	1.2	1.2	1.0	1.2	1.2
Fe_2O_3	1.1	1.1	0.9	1.5	1.6
CuO					
As_2O_3					
PbO				1.0	
Sum	100.0	100.0	100.0	100.0	100.0
Provenience	Aumale ?	Geneva - La Balme ?	Montereau, marked	Creil, marked	Creil, marked
Dating	1824/25 - 1831	1797-1810	1800-1815	1797-1832	1707-1832
Literature				[MA15]	

Table 9.9: *SEM-EDS analytical results of the body matrix of the three plates and of two from Creil. Results normalised to 100 wt. %.*

An. No.	**VAL 1**	**VAL 2**	**VAL 3**	**Creil-2**	**TBL 2**	**VAL 1**	**VAL 1**	**VAL 2 - 23**	**VAL 2 - 33**	**VAL 3 - 63**
Location	Upper third of the glaze					Close to the body	Between the pigments			
Surface analysed (µm)	60 x 15	240 x 200	110 x 25	40 x 150		60 x 15	90 x 25	22 x 10	8 x 3	15 x 5
Na_2O	0.4	0.4	0.4			0.4	0.6	0.6	0.6	0.6
MgO	0.2	0.3	0.2		0.2	0.1	0.2	0.4	0.4	0.2
Al_2O_3	0.1	0.2			7.8	0.9	0.1			
SiO_2	34.2	34.6	35.3	25.9	30.5	36.2	34.5	34.4	34.5	35.5
SO_3	1.7	2.0	2.2			1.7	1.6	1.7	1.5	2.4
Cl	0.8	0.4	0.4	0.5		0.7	0.7	0.3	0.3	0.4
K_2O	2.8	3.0	2.7	0.3	0.6	3.3	3.5	3.2	2.7	2.8
CaO	0.3	0.3	0.5	0.4	0.1	0.2	0.6	1.2	1.0	0.9
TiO_2	0.1				0.2	0.1	0.2			
Mn_2O_3							1.3	0.4	0.8	0.6
Fe_2O_3	0.2	0.2	0.2	0.3	0.4	0.2	2.3	0.5	1.2	3.3
CuO	0.1					0.2		0.2		0.4
As_2O_3		0.4							0.1	
BaO									0.5	
PbO	59.1	58.2	58.1	72.6	60.2	56.0	54.4	57.1	56.4	52.9
Sum	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 9.10: *SEM-EDS analytical results of the glazes of the three plates and two from other factories (Creil-2, marked plate: [MA15]; TBL-2, Sarreguemines, marked plate: [MA11]). Results normalised to 100 wt. %.*

An. No.	**Surface analysed (µm)/Spot**	Na_2O	MgO	Al_2O_3	SiO_2	SO_3	Cl	K_2O	CaO	TiO_2
I) Fe										
VAL 1-1	25x10	0,4	0,1	0,1	1,5	0,1		0,1	0,1	
VAL 2-27	5x5									
VAL 2-32	Spot						0,2			
VAL 3-57	Spot									
VAL 3-58	Spot									
VAL 3-60	10x6									
II) Mn										
VAL 2-21	2x2	0,9	0,2	0,2	0,6	0,1	1,1	0,2	0,2	
III) FeMn										
VAL 2-67C	Spot				0,4			0,1	0,3	
VAL 2-68R	Spot				6,4			0,3	0,5	0,1
VAL 3-55	Spot		0,1	0,3	0,6					
IV) MnBa										
VAL 2-29	15x8	0,8	0,3	0,4	2,1	4,8	0,3	0,3	0,3	
VAL 2-34	20x10	0,8	0,6	0,5	1,1	0,4	0,1	0,3	0,3	
VAL 2-35	Spot	0,3	0,1		2,9	0,5		0,3	0,2	
VAL 3-53	12x6	1,7	0,1	0,5	0,3			0,1	0,3	

An. No.	**Surface analysed (µm)/Spot**	Mn_2O_3	Fe_2O_3	CoO	CuO	As_2O_3	BaO	PbO	**Sum**
I) Fe									
VAL 1-1	25x10	0,9	95,3					1,4	100,0
VAL 2-27	5x5		99,2					0,8	100,0
VAL 2-32	Spot	0,7	90,0					9,1	100,0
VAL 3-57	Spot	2,2	97,2	0,6					100,0
VAL 3-58	Spot	1,0	98,3	0,7					100,0
VAL 3-60	10x6	1,2	98,2	0,6					100,0
II) Mn									
VAL 2-21	2x2	88,1	0,7		3,8		0,1	3,8	100,0
III) FeMn									
VAL 2-67C	Spot	72,0	3,8		2,9		0,1	20,4	100,0
VAL 2-68R	Spot	74,5	2,7		2,6			12,9	100,0
VAL 3-55	Spot	42,8	54,6	0,5	0,8	0,3			100,0
IV) MnBa									
VAL 2-29	15x8	56,1	1,2				19,0	14,4	100,0
VAL 2-34	20x10	66,1	1,1				18,2	10,5	100,0
VAL 2-35	Spot	64,5	0,8				14,6	15,8	100,0
VAL 3-53	12x6	61,5	2,8				32,7		100,0

Table 9.11: *Transfer printed decorations: SEM-EDS analytical results of the « black to greyish » crystals. Results normalized to 100 wt. %.*

An. No.	SiO_2	Mn_2O_3	Fe_2O_3	BaO	PbO	**Sum**	**Lit.**
VAL 1-1	17.8	8.0	15.3	0.2	58.6	100.0	
VAL 2-1	16.8		25.1		58.1	100.0	
VAL 2-2	26.2	3.4	12.0		58.4	100.0	
VAL 2-3	21.8	16.6	5.2		56.4	100.0	
VAL 2-4	22.7	11.2	8.3		57.9	100.0	
VAL 3-1	19.2	10.2	13.7		56.9	100.0	
VAL 3-2	22.4	3.7	15.3		58.5	100.0	
Kentrolite	15.95	22.26			59.00	98.00	b
Kentrolite	16.59	21.79			61.62	100.00	c
Melanotekite	16.55		21.99		61.47	100.0	a
Kentrolite - Melanotekite	16.45	13.55	6.62		59.59	96.21	b

Table 9.12: *Transfer printed decorations: SEM-EDS analytical results of some « white » crystals (= kentrolite-melanotekite mixed crystals) surrounding the « black to greyish » crystals. Recalculated results, including only the oxides relevant to the black pigments. Published analyses: a =* `https://www.webmineral.com/data/Melanotekite.shtml` *(accessed 5.7.2024), b =* `https://rruff.info/doclib/hom/kentrolite.pdf` *(accessed 5.7.2024), c = [MO91].*