

Chemical Analysis of Italian Sigillata from Italy and from the Northern Provinces

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Aims

In 1990 a paper in the *Conspectus* summarized the experiences with chemical analyses of Italian Sigillata¹. In the meantime new data were received. A major problem in the determination of provenances of Italian Sigillata are missing reference groups. This is the archaeological problem. The analytical problem is precision and accuracy of the chemical data produced in different laboratories and the interpretation of the data. Multivariate statistic tests help to find or to confirm groups but regarding the individual elemental concentration is essential and sometimes contradicting. The data therefore have to be discussed taking analytical and geochemical arguments into account. Thin section studies and MGR-analysis² have been used in addition to analysis by WD-XRF but these methods can not replace chemical analyses of major and trace elements.

Reference groups

The archaeological problem

In Italy only few workshops for Sigillata were excavated. As was done in the *Conspectus*, the workshops of Lyon here will be included. For these excavated workshops chemical analyses of the products were done, mainly by wavelength-dispersive X-ray fluorescence (WD-XRF) in the collaborating labs of M. Picon in Lyon and G. Schneider in Berlin. Chemical analysis and other laboratory studies were done for Arezzo, Cincelli, Pisa, Lyon, Torrita di Siena, and, analyses published by G. Olcese in 2003, Vasanello and Scoppieto. For the latter also three analyses were made in Lyon by V. Thirion-Merle³ but

not matching those published by Olcese⁴. For the region of Naples reference groups by WD-XRF, MGR and thin section studies exist for Puteolana, for *Cales*, for *Produzione A della baia di Napoli* (formerly called *Tripolitanian Sigillata*) and, in south Italy, for *Ortona*. The latter, however, is represented only by few chemical analyses. In north Italy reference groups for Sigillata Padana and Tardopadana are well established but without knowing the exact places of production. There is a clear need for more information on possible workshops by archaeological and archaeometric methods.

In cooperation with numerous archaeologists and projects finds were analysed in Berlin from several sites and from differing periods with varying numbers of samples. In the north amongst these were Dangstetten, Haltern, Nijmegen, Oberaden, Velsen and Vechten. South of the Alps finds were analysed from Magdalensberg, Aquileia, Rome, Pompeii, Velia, Monte Iato, Carthage and others. Many of the analysed sherds beforehand were attributed by the archaeologist to one of the major production centres. In most cases these attributions were correct. This is, maybe, the most important result of our analyses. The analysed samples then can be used to enlarge the data base for the reference groups. This applies especially in cases where an insufficient number of sherds found at the true places of production are available for chemical analysis. On the other hand,

¹ SCHNEIDER - HOFFMANN 1990.

² E. g. DASZKIEWICZ - SCHNEIDER 2002.

³ BERGAMINI 2003, 142.

⁴ OLCESE 2003, 23.

sherds for which the archaeological and the chemical attribution did not agree may provide new insights into the relation of names or stamps and production centres. This will be one of the main points in our discussion.

The analytical problem

The general problems connected with reference groups were discussed earlier⁵. The differences in chemical composition between most of the reference groups of Italian sigillata are small. For this reason analyses have to be very precise. As not all analyses were done in only one lab, accuracy of the

listed in Table 1. For an easier reading only the most important elements in WD-XRF are presented and standard deviations omitted. Concluded from the comparison of analyses it is clear that very small shifts only can be interpreted if the data were made by the same lab where unexpected differences can be checked by repeating the analysis.

Arezzo A and Arezzo B represent two subgroups of Arretine Sigillata, group A being higher in calcium and strontium contents connected with minor differences in other elements. These two subgroups are clearly distinguishable using multivariate tech-

	SiO2	TiO2	Al2O3	Fe2O3	HgO	CaO	Na2O	K2O	P2O5	Cr	Mn	Rb	Sr	Br
WD-XRF Berlin:														
Arezzo A	53.8	0.84	18.0	7.24	3.50	13.1	0.80	2.40	0.27	166	88	118	341	130
Arezzo B	56.1	0.87	18.8	7.48	3.51	9.4	0.80	2.61	0.30	179	90	138	274	136
Dangstetten	54.5	0.91	19.2	7.68	3.63	9.6	0.73	2.39	1.22	165	84	103	274	139
Other analyses by WD-XRF:														
Picon	54.8	0.84	18.2	7.32	3.51	11.4	0.66	2.51	0.34	153	93	132	317	144
Maggetti	55.8	0.89	18.3	7.26	3.80	10.5	0.82	2.56	0.34	158	90	125	280	145
Hello	54.3	0.88	17.7	7.16	3.27	10.8	0.86	2.75	0.42	190	84	130	340	190
Analyses by NAA:														
Widemann		0.80	17.4	7.49		13.3	0.82			162	98	132		
Pefia (Blackman)				7.18		9.4		2.46		192		150		
Gunnweg		0.77		7.16		10.1	1.02			175		141		
Wissemann*				7.27			0.82	2.74		173		127		
Analysis of the ceramic reference sample SARM69:														
Berlin	66.4	0.779	14.6	7.25	1.87	2.37	0.86	1.96	0.27	217	54	67	112	293
certified	66.6	0.777	14.4	7.18	1.85	2.37	0.79	1.96	(0.28)	223	53	(66)	109	271

* corrected for a constant factor of 1.35

Table 1. Comparison of averages for chemical analyses of Sigillata from Arezzo in various labs and by various methods (a) and control analysis of an international reference sample (b).

data is important, too. If the accuracy is sufficient, data from different labs can be compared directly. The comparability of the analyses done by WD-XRF in Lyon, Berlin and that of M. Maggetti in Fribourg repeatedly was checked by analysing samples exchanged between these labs⁶. Analyses done in other laboratories by this method or by neutron activation (NAA) more or less agree (table 1). To give an idea of the accuracy of our data, the results for a new international reference sample (SARM69), analysed by us before the standard was certified, are also

listed in Table 1. Group A nearly exclusively includes the products of Ateius in Arezzo. New analyses of Sigillata from Dangstetten showed, however, that also some other potter's products were included in this group A.

The third row in Table 1 presents the average of the analyses of Sigillata found in Dangstetten attributed to a provenance from

⁵ SCHNEIDER *et al.* 1979; SCHNEIDER - HOFFMANN 1990.

⁶ E. g. GALLETTI 1994.

Arezzo. The most obvious difference to the reference group is the phosphorus content which is higher in the finds from Dangstetten. This is due to an absorption of phosphates during burial of the sherds in the ground which mostly, but not always, is connected with an absorption of barium and, sometimes, also other elements. This effect under certain burial conditions is connected with leaching of elements like rubidium, potassium, sodium, calcium. Due to this leaching the more stable elements like titanium, aluminium, iron, chromium are slightly higher in the samples from Dangstetten than in the reference group from Arezzo. Multivariate calculations of probabilities therefore do not attribute most of the Dangstetten samples to the given reference group of Arezzo, but this obviously does not make archaeological sense.

Arezzo and Lyon

In the following discussion only two elements, titanium (Ti) and magnesium (Mg), will be regarded to demonstrate the problems connected with the attribution of analysed samples to the Arezzo group. Such univariate or bivariate considerations should be done for all analysed elements before any multivariate statistic is applied which hides such information and may lead to misinterpretation.

The first example is Sigillata of the potter *Lucius Gellius*. If we only consider the two elements Ti and Mg, he obviously worked at least at two different places, one with clays having magnesium contents below 2.5 % MgO and one with higher Mg contents. Most of the samples with high Mg fall into a field which includes all our analyses of Sigillata made and found in Arezzo. In the diagram (fig. 1) this field is identical with the field of such data generated in the lab of M. Picon in Lyon. The chemical similarity of most of the *Gellius* samples and the reference group Arezzo is confirmed by all other elements, as it should be. Quite a lot of analyses, how-

ever, do not fall within the field of Arezzo. The analyses with higher Ti belong to sherds found in the lower Rhine valley which mostly are connected with high phosphorus (P) contents. The two points with highest Ti contents in Fig. 1 represent analyses of sherds with more than 10% P₂O₅. Thus, all analyses with too high Ti belong to altered sherds and thus can be attributed to Arezzo. The differing analyses with too low Ti and the analyses with too high Mg, however, can not be explained by alteration of sherds originating from Arezzo.

The large group with very low Ti and Mg in the diagram does not exactly match the reference group for sherds manufactured and found in Lyon and analysed by M. Picon. The higher Ti again can be explained by the changes during burial which for Sigillata produced in Lyon are much more intense than for Sigillata produced in Arezzo (or in La Graufesenque). For the same reason, analyses of sherds from several sites in the northern provinces, most probably originating from the Lyon region, show the same tendency of higher Ti compared to the finds in Lyon. On the other hand, the lower Mg contents of these finds compared to the reference group can not be explained by secondary effects and may indicate other production centres within the Lyon area. This idea is strongly supported by significant differences in the contents of other elements.

Stamps and places of production

On the basis of many analysed sherds bearing stamps we can now discuss potter's workshops. As we have seen in the case of *Gellius* the same name does not necessarily mean the same workshop. On the other hand, different names are found in the same workshop area where these potters used the same clay. Sometimes different types of stamps indicate different workshops. This will be discussed using some names of potters as an example and a bivariate plot (fig. 2) to make it clear. The first potter to be regarded is

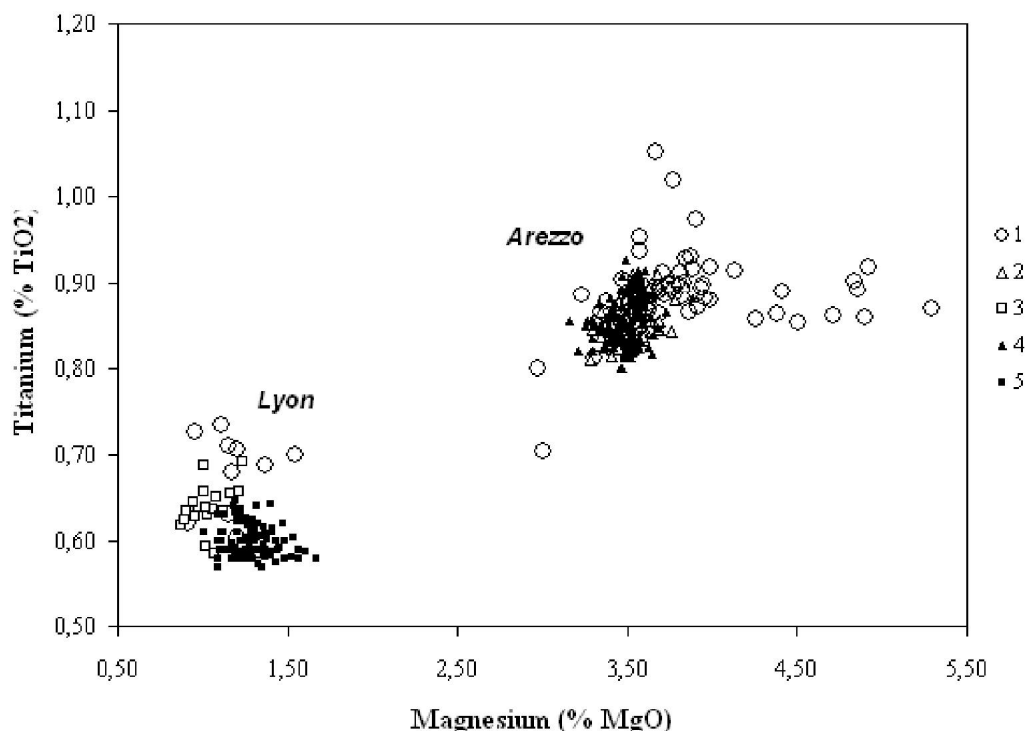


Fig. 1. Bivariate plot titanium/magnesium of the composition of Sigillata of *Gellius* and of the reference groups for Sigillata from Arezzo and Lyon (analyses by WD-XRF): 1 = 73 analyses of Sigillata with various types of stamps of *Gellius* from various sites; 2 = reference group Arezzo, n = 103 (G. Schneider); 3 = analyses of Sigillata from Lyon found at various sites, n = 19 (G. Schneider); 4 = reference group Arezzo, n = 135 (M. Picon); 5 = reference group Lyon, n = 105 (M. Picon).

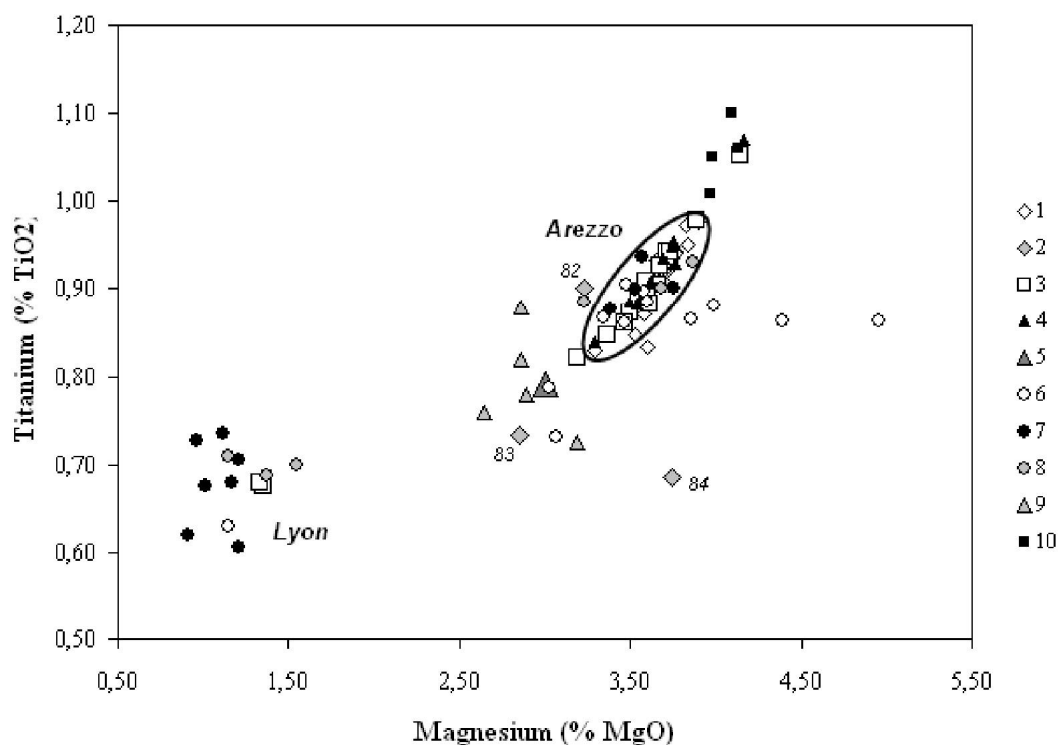


Fig. 2. Bivariate plot titanium/magnesium of Italian Sigillata of various potters: 1 = *SEX. ANNIVS* (OCK 183); 2 = *SEX. ANNIVS* (OCK 184), found in Ostia (OLCESE 2003); 3 = *SENTIVS* (OCK 1854, 1861, 1863, 1866); 4 = *A.TITIVS* (OCK 2166); 5 = *C.ATI* (OCK 323); 6 = *L.GELLIVS* (OCK 879); 7 = *L.GELLIVS/L.SEMPRONIVS* (OCK 882); 8 = *L.SEMPRONIVS/L.GELLIVS*; 9 = *PRIMA* (OCK 1523), *PRIMVS* (OCK 1532); 10 = various potters (see text), chemical group IV. The ellipse frames the samples from Dangstetten attributed to Arezzo but it does not have any meaning in terms of a calculated statistical probability.

Sex. Annus. Thirty sherds from Dangstetten with the stamp OCK 183 were analysed and all ten variants of this stamp, distinguished by K. Roth-Rubi, fall within a narrow frame of chemical composition matching the reference group Arezzo. Two analyses from finds in Carthage⁷ also can be attributed to Arezzo. This is, however, not the case for three analyses of finds in Ostia with stamps OCK 184⁸. In Fig. 2 these analyses are marked with their sample numbers 82-84. Sample 82 is not so far from the Arezzo field, however, its potassium content is too high. In spite of some similarity in other elements, the two elements Ti and Mg clearly show that these three analyses can not be attributed to Arezzo and probably even not to only one production centre. This is clear from regarding just the two significant elements without any statistical techniques. Since the three analyses had been made in our lab, like all other analyses included in the diagram, the differences must be real. This example shows that here the different stamps OCK 183 and OCK 184 indicate different workshops.

Also the potter *C. Sentius* apparently produced at various places (fig. 2). Four variants of the stamp OCK 1861, found in Dangstetten and Oberaden, belong to the Arezzo group. The finds from Oberaden include also one stamp *SENTIVS* (OCK 1854:2). For two variants of OCK 1861 (OCK 1861:9 and 1869:10) the attribution is less clear. In fig. 2 these samples are the two square symbols just at the lower and upper end of the ellipse, both maybe outside the Arezzo field. Two further analyses, finds at Haltern with the stamps 1863:3 and 1863:9, clearly can be attributed to Lyon (in fig. 2 the symbols overlap). Another analysis of a similar stamp (OCK 1863:3s), however, can not be attributed to Lyon and, probably, also not to Arezzo. In fig. 2 this is the empty square with the highest Ti. In all analyses available for Sigillata from Arezzo such high contents of Ti (connected with high Fe, Cr, Ni) never were determined. Secondary effects can here be excluded. However, other potters as *Titius* OCK 2166 (fig. 2, group 4) and some other names

(fig. 2, group 10) fall into this new chemical group of finds in Haltern and Oberaden. Why this group is not represented within the large series of finds from Arezzo or Dangstetten? Is this indicating a further production centre in the region of Arezzo using similar clays or different layers of the same clay? Has this to do with chronology?

As a next example we will come back to *Lucius Gellius*. Most of the finds analysed from Magdalensberg and other sites match the reference group Arezzo, if we take secondary effects into account. Some analyses, however, are too high in Mg to be attributed to Arezzo (fig. 1, in fig. 2 only four repeated analyses were included to be sure that the differences are not analytical errors). Probably we have again to hypothesize a further yet unknown production centre for these samples. Another group of provenance are the only two examples of *L. Gellius* (OCK 879:16) found in Dangstetten. This group with too low Ti and Mg for Arezzo includes also samples of the potters *Prima* (OCK 1523:1) and *Primus* (OCK 1532:15). There is some similarity to the composition of Puteolana and in the same time to the major group of Sigillata found in Rome but, regarding the whole series of elements, the analyses in fig. 2 can not be attributed to one of these groups. The analysed one sample of *Ati* (OCK 323:3), also included in fig. 2, indicates a further provenance group distinguished from the group of *Prima/Primus* by a much higher potassium content. From comparison with the analyses done until now for Sigillata from Vasanello and Scoppieto⁹ these centres can be excluded but far more analyses are needed for a clearer picture.

Only one of the analysed samples of Sigillata of *L. Gellius* is from Lyon. It was found in Neuss and analysed by M. Picon. On the other hand, most but not all of the

⁷ HEDINGER 1999: stamps S 16 and S 17.

⁸ Published by OLCESE 2003, 21.

⁹ OLCESE 2003 and BERGAMINI 2003.

stamps where *L. Gellius* is combined with *L. Sempronius* are from Lyon (Fig. 2). Both types of stamps, those with *Gellius* first and those with *Sempronius* as a first name are made as well in Lyon as in Arezzo. On the other hand, it seems that the products of Lyon are only found north of the Alps. This example shows that the interpretation of stamps is not easy without chemical analysis.

Conclusions

In spite of the many chemical analyses done on Italian Sigillata many questions are still open. Was the clay used in Arezzo always the same? Is there a chronological shift in composition? How to interpret the higher calcium content of the products of *Ateius*? Are there more such minor centres in the area like Cincelli and could be these the places of provenance for the sherds with higher titanium contents found in Haltern and Oberaden?

Most of the reference groups, besides Arezzo, Pisa and Lyon, are established with only few analyses and need more data to be statistically significant. The many compositional groups of Sigillata found in Rome still can not be attributed to kiln sites or production centres. The same applies for the Sigillata found and produced (?) south of Naples. In north Italy the true places of production for Padana and some other groups still have to be found. For the products of the Lyon area is still an open question why the finds in the north rarely match with the reference group for sherds from Lyon.

The attribution of names and stamps on Italian Sigillata to certain places of production still needs more work. At least, an attribution just based on names could be misleading. The macroscopic classification without chemical analyses works in many cases but it does not always and the exceptions are the important objects. Minor variants of the stamps have to be considered to avoid misinterpretation. Here the only secure way is chemical analysis and an enlarged data base for comparison.

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Abstract - The paper provides some information on the Berlin databank of chemical analyses of Italian Sigillata. The problems connected with the attribution of chemical data to the reference group of Arezzo are discussed using the titanium and magnesium contents as an example. Besides the reliability of the reference group these problems are precision and accuracy of the data and chemical changes during burial of the sherds in different soils. Analysis of a large series of stamped Sigillata from sites in the northern provinces yielded some unexpected results. It was nothing new that the same names as *Ateius*, *Gellius* or *Sentius* appeared in different provenance groups. Mostly this correlates with different types of stamp, indicated by different OCK numbers but in a few cases even similar variants of the same type of a stamp did not come from the same workshop, if we define a workshop by the use of only one type of raw material with the same chemical composition.