

Plaster Investigation

Aims and objectives

To understand how the Romans prepared and worked plasters for wall paintings, and to investigate the possibility of using plaster analysis for the dating of stratigraphic layers are the two objectives of my research. There is a notable distinction between plasters used at Pompeii over time, and these differences might show a relationship between specific plasters and specific periods. The main objective with this study is to establish if there is a clear correlation between typology and chronology, and to establish if such a correlation can be proved by petrographical and chemical investigation. If non-subjective methods of analysis confirm observations made under the microscope, it would mean that specific plaster types can be recognized and their characteristics explained.¹ If these plaster types appear in the same chronological order in houses spread over the site, then it would be possible to create a reference system and use ocular plaster analysis as a complementary tool for the dating of decorations and re-decorations at Pompeii. Such a tool would be useful in cases when the painted decoration has disappeared, or when traces of an early decoration are visible as seams behind later constructions. The method may in any case be used for comparative studies of the relative chronology within a house. Another long term objective is to study possibilities of reconstructing and using ancient technology for conservation interventions.

Objects of the study

Houses in *insula* I 9 constitute the basis of my research, to which samples from other structures at Pompeii are compared. The observations from the studies of the standing structures within the *insula*, made by the archaeological team of the British School at Rome, provide the facts with which my own observations are evaluated.

In the spring of 2004 this investigation was extended to the Forum, the object of the archaeological project of the University of Virginia, named the *Pompeii Forum Project* (PFP). The buildings in these areas, described under separate headings, offer examples of the four Pompeian styles.

Problems

that need to be answered are

- a) Is it possible to establish the existence of different kinds of plasters used over time in Pompeii?
- b) Is it possible to establish a correlation between a specific type of plaster and a specific period in time?
- c) if so, is such a link valid within a single house or applicable to houses within the area of Pompeii?

¹ I do not believe there is a method, which in the end, is absolutely objective, since questions posed as well as interpretations of results achieved are subjective. Chemical-technical investigations produce, however, non-subjective facts.

Design of the study

This investigation can be divided into four distinct areas: studies *in situ*, analyses of samples, laboratory analyses and considerations on archaeological and art historical issues. Studies of relative stratigraphies, sampling and documentation constitute the initial phase, considerations on art historical and structural issues belong to the next. Petrographical and technical analyses have been performed separately. Finally, there is a long period of checking, crosschecking and studying these aspects as different parts of one entity.

Methods used

The methods used, are

- a) qualitative analysis of the components in small samples of wall plaster *in situ*,
- b) petrographical and technical investigations in the laboratory,
- c) considerations on standing structures and Pompeian styles

a) The composition of small plaster samples was studied under the microscope *in situ*. The variables studied are defined below under a separate heading. Each sample was registered on a list over samples taken in the building as well as on separate forms, described under the heading documentation.² By defining and studying the variables it was possible to sort plaster samples into types and plasters into groups. Reference samples, plaster types and groups are discussed below. Furthermore, I created a simple but useful data-base in which the components in the fillers are registered (see appendix). This was a break-through. Information became controllable.

b) Several samples from each group, in all of the buildings investigated, have been examined at the CNR-ICVBC in Florence (see appendix). The investigation consisted of stratigraphic analyses of thin sections in optical microscopy, photographed in polarized transmitted light and under UV radiation.³ Analytical methods used were FTIR and XRD.⁴ The chemical compositions and the mineralogical components of the samples have been investigated. Plaster as well as preparations for painting (stucco), have been examined, but only the plasters are used for classification in this study. Consequently, the stucco layers are considered as additional information which may or may not be indicative. The grain size within the filler was classified according to three variables: well-classed (mainly of one size), medium-classed (varied grain size) and un-classed (all kinds of dimensions). Its constituents, almost exclusively volcanic matter, were registered; the shape of the grains defined and their dimensions noted, measured in μm (100 μm is 0.1 mm). The binder was defined according to the criteria of abundance, porosity, homogeneity, structure, i.e. micritic or microsparitic, and in some case, the opacity was noted. Based on these definitions, the plasters were placed into groups with the same characteristics. The groups of plasters that had been identified by chemical and petrographical investigation were compared to the groups identified by data collected *in situ*. The results from the two investigations were compared and discussed at several meetings. An additional sample of salt efflorescence was taken from the east wall

² The lists are presented in connection with the discussion on the buildings, the sample forms as appendices.

³ An optical microscope Zeiss Eclipse 501, equipped with objectives from 1x to 40x, white light and with a high pressure UV lamp was used.

⁴ Fourier Transform Infrared Spectrometry and X-Ray Diffraction.

decoration in room 8 at the Casa del Bell'Impluvio and studied. The efflorescence was caused by Portland cement that had been used for the restoration of the wall.⁵

c) Wall constructions and decorated wall plaster are linked to phases of the history of Pompeii and to building and redecoration phases within the house. A painted decoration is generally referred to as belonging to one of the four Pompeian styles, a reference that automatically places the decoration within a limited period of time. Consequently, information regarding construction methods and Pompeian styles is valuable for the understanding of collected data.⁶

Variables studied

The primary variables studied are,

- a) the characteristics of the lime,
- b) the components in the filler, and
- c) the proportions between lime and filler.

Secondary variables studied are

- d) the state of preservation of the sample,
- e) the state of preservation of the wall.

a) Lime plaster is composed of sand, slaked lime and water. Sand is the filler; lime and water make the binder.⁷ Lime is produced by burning calcium carbonate (CaCO_3), i.e. limestone or marble, to about 900-1000 degrees, transforming it into calcium oxide (CaO), i.e. quick lime.⁸ When water is added, a reaction starts, producing heat, resulting in calcium hydroxide ($\text{Ca}(\text{OH})_2$), i.e. slaked lime. The slaking process continues for a long period, and to ascertain that the process is completed, the lime should be kept in closed pots or caves for years. Slaked lime can be smooth and even, but it may also contain lumps of lime that are residues of the burning and slaking process. It is generally of a white or creamy white colour, depending on the kind of limestone or marble that was used for making it. Also dolomite, ($\text{CaMg}(\text{CO}_3)_2$), can be used to produce lime.

b) At Pompeii, the filler consists almost exclusively of volcanic particles, such as pyroxenes and pumice.⁹ The components within the filler may be linked to the area at the Somma-Vesuvius complex from where it was taken, just as the composition of white marble varies from one cave to another. Hypothetically, different caves provided fillers at different periods. Some fillers are mainly black and grey, others are multicoloured. The grains are shaped and coloured in different ways, due to their chemical composition and connected to circumstances during which they were originally created or later ground.

⁵ The constituents were principally thenardite (Na_2SO_4) (i,x) and traces of gypsum and potassium and sodium and calcium sulphates (aphthitalite, $\text{K}_3\text{Na}(\text{SO}_4)_2$; syngegite $\text{K}_2\text{Ca}(\text{SO}_4)_2 \cdot \text{H}_2\text{O}$).

⁶ The Four Pompeian styles: 1st style, c. 180-80 BC. At least as old as the earliest houses built toward the beginning of the second century BC; 2nd style, c. 80-20 BC. From the time of the Sullan colony, continued until the end of the century; 3rd style, c. 20 BC-AD 45. From the time of the second triumvirate down to the time of Tiberius. On Pompeian painting, see, e.g., Barbet 1985, Ehrhardt 1987, Laidlaw 1985.

4th style, c. AD 45-79. This phase can be divided in two periods, before and after the earthquake in AD 62.

⁷ 1 part slaked lime and 2 parts sand is conventional but there are variations.

⁸ On issues related to lime, see Bläuer-Böhm & Jägers 1997, Marchese et al 2001, 24, 27.

⁹ Grave 2002, 62, Sabbioni et al 2001, 39f, Meyer-Graft & Ehrhardt 1998, 317. Bracci & Fratini (forthcoming).

Most particles are pumice: opaque, dark grey, black or brown, rounded, with a more or less porous surface. Pyroxene crystals appear in most fillers and are of a high percentage in some. The pyroxenes are of two kinds: ortopyroxenes and clinopyroxenes.¹⁰ The former are long black, rhombic crystals. The latter are monocline, transparent and translucent, generally uncoloured, or yellow, green or grey. Red or orange-red porous particles are present as grains or as powder. Bright yellow particles, resembling sulphur, may occur but also reused materials, such as paint flakes, ceramics or glass (*Fig. 6*) can be observed in Pompeian plasters. The specific particles within the filler is one of the variables that is studied. These distinctions can be observed under the microscope. In order to understand the reasons for such variations and to explain in what these distinctions existed, it was necessary to combine the method used *in situ*, which is a qualitative analysis of the components in small samples of wall plaster, with non-subjective methods, such as petrographical and chemical investigations. Such analyses have been performed at the Istituto per la Conservazione e la Valorizzazione dei Beni Culturali (ICVBC) in Florence.

Another aspect is the grain size, but not in the sense of successive layers of finer plaster, as recommended by Vitruvius.¹¹ Plasters may have large grained fillers, i.e. the particles are homogeneously of a rather large size. The lack of small particles often causes cracks or hollows in the plaster when it sets. A well-balanced and solid plaster contains grains of various sizes, where those of a smaller size fill the spaces between larger grains.

c) The proportion between lime and filler is yet another variable. Some plasters are clean and well proportioned. Others seem to be hastily made of reused materials, mixed with fresh lime.

d, e) There are also secondary factors to consider, such as the impact of the environment. Plasters in protected areas are generally in a better state of preservation than those found on unprotected walls, and in particular on areas at, or below, the present floor level. Plasters may be very frail and fall apart when touched. In such cases, it is impossible to obtain a solid sample. The same kind of plaster may, on the other hand, be perfectly solid at another sampling spot, indicating that the frailty is due to decay, caused by environmental factors.

Documentation

The methods of documentation have been colour photographs with indications on sampling areas, descriptive sample forms, lists over registered samples, and photographs of reference samples, plans with indications of sampling areas and of stratigraphic layers.

Reference samples, types and groups

Sampling begins where there is a clear stratigraphic order, possibly in connection to an ascertained 1st style decoration with the objective of starting the study in each house at the earliest possible phase. The sampling spot is indicated on a plan of the building and on a photo. The samples, generally about 5 mm in diameter, receive identification numbers by the initial letter of the house and the order in which it was taken, e.g., BI 1 (Casa del Bell'Impluvio, sample no. 1). Number one, being the first sample and type, is always a reference sample. Sample no. 2 is removed from a layer that covers no. 1, and normally this belongs to a later period (*Fig. 7*). Therefore no. 2 is generally a reference

¹⁰ Font Altalba & Tanelli 1986, 78f, Steinbach & Medenbach 1989, 28.

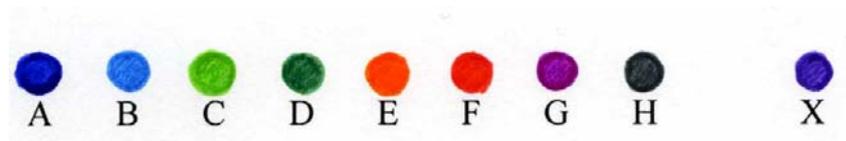
¹¹ Vitruvius VII, 3.

sample too. At the Casa di Amarantus, a 1st style decoration is covered by one of the 4th style.¹² Intermediate decoration periods appear at other walls, and these plaster types are chronologically placed between reference sample nos. 1 and 2.¹³ Each building in the *insula* was studied separately. The results were then evaluated and finally those achieved at *insula* I 9 and at the Forum were compared.¹⁴

As explained above, each reference sample represents a type of plaster in a house, connected only with that building. Later, these reference samples, i.e. the types identified in the single houses, are compared to reference samples in other buildings. Those that are of the same kind constitute one group. The many plaster samples that may constitute one group are, in a typological perspective, of the same kind, i.e. one type.

Colour code

A colour code has been made with the primary objective of illustrating relative stratigraphic layers of plaster. It is used on plans of the houses, illustrating the stratigraphic layers of the sampling areas indicated on the plan next to it. The colour code is also used to illustrate stratigraphic layers in the rooms and other areas investigated. Early plasters have been given blue colours, followed by green, orange, red, violet and grey. In a few cases, undefined repair plasters and *cocciopesto* have been noted as X, and given violet colour. These materials are not part of the study but, being samples, these have to be noted.



Archaeological and art historical considerations

Pompeian plasters are part of wall paintings that have been thoroughly studied for centuries. The periods to which Pompeian wall decorations belong are well-defined, even though there are minor disagreements in the dating of specific paintings, some of which depend on the more or less strict way of dating, e.g., in early and late periods within a style. The archaeological study of standing structures provides established dates; certain kinds of wall constructions did not occur until after a specific date. Taking these kinds of aspects into consideration is of vital importance, they are all part of the same context.

¹² The same occurs at Casa del Bell'Impluvio and the Temple of Jupiter.

¹³ The relative chronology between ref. sample nos. 1 and 2 in Casa di Amarantus is: A 1, A 4, A 6, A 2.

¹⁴ Preliminary results were presented in spring 2004 in "Report on Pompeian Plasters. Insula I 9", and in autumn 2004 in "Report on Pompeian Plasters. Forum".



Fig. 6. *Above*: I 9 11 Casa di Amarantus. Plaster on the east wall in the bar area, room 2, containing crushed and reused materials, such as ceramics, glass and marble.

Fig. 7. *Below*: I 9 13 Casa di Cerere room 6. An early decoration, covered by a later period.