

Building a necropolis in roman age: geomaterials from the "Porta mediana" in Cuma.

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Abstract – Geomaterials from Campanian region have been widely used since ancient times in the local architecture both for their high availability in the area and good petrophysical features. An outstanding example is the archeological site of "Porta Mediana" Necropolis of Cuma, consisting of about 70 mausoleums ranging from 4th B.C. and 6th century A.D. and revealed by the Centre Jean Berard, from 2001 till present. This study, carried out on geomaterials from all the funerary monuments of the site, was performed by using consolidated experimental methods, such as optical microscopy in polarized light (OM), and X-ray powder diffraction analysis (XRPD). Results showed the presence and the wide use, as building stones, of mainly local materials, belonging to volcanic and sedimentary lithotypes. Regarding artificial geomaterials, such as mortars and cocciopesto, the use of volcanic aggregates of local origin is confirmed too.

I. INTRODUCTION

"Porta Mediana" Necropolis is located in Phlegrean Fields area, within the wide archaeological site of Cuma, the oldest Greek colony of the Occident. The Necropolis consists of 70 mausoleums (fig. 1), ranging from 4th B.C. to 6th century A.D., developed in different building phases, as revealed by archeologists of the Centre Jean Berard within the 'Kyme 3' project [1].

This study, carried out within the research activities of PON SINAPSIS (Sistema Nazionale Protezione Siti Sensibili), aims to improve the knowledge on raw materials used in funeral monuments by means of a deep minero-petrographical characterization. Results of this research can be considered as a starting point to plan right actions both for a conscious use and the conservation of this invaluable cultural site.

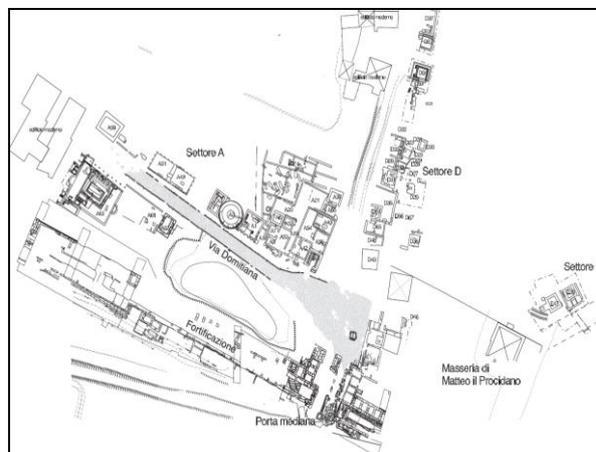


Fig. 1. Sketch map of Porta Mediana Necropolis

II. GEOLOGICAL SETTINGS

The archaeological site is located on a trachytic lava dome [2], in the north-western side of the Phlegrean Fields (Campania region, Southern Italy; fig. 2), one of the most important, still active, volcanic district in the Mediterranean area [3].

The geological history of the Phlegrean Fields has been dominated by two main eruptive events: the Campanian Ignimbrite (39 ka - [3]) and the Neapolitan Yellow Tuff (15 ka - [4]) eruptions. From petrographic point of view, these volcanic products belong to potassic series with shoshonitic affinity (KS) and were used for building purposes since ancient times [5 - 6].

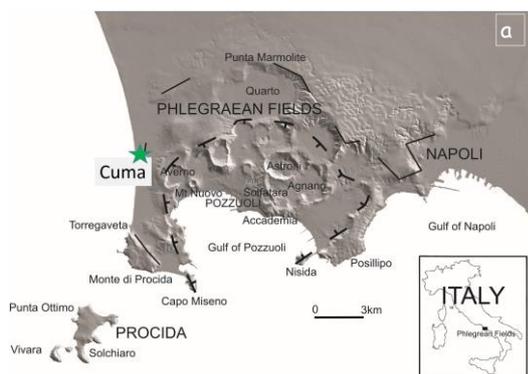


Fig. 2. Sketch map of the Phlegrean Fields with location of Cuma (Naples).

I. MATERIALS AND ANALYTICAL METHODS

Different sampling campaigns allowed to collect the following geomaterials:

- 50 volcanic lithotypes (tuffs and lavas);
- 60 mortars and plasters;
- 17 *cocciopesto*;
- 6 limestones;

Mineralogical and petrographical characterization was carried out by different and complementary techniques.

The main petrographical features were obtained by polarized light microscopy (Leica Laborlux 12 pol) on thin sections. XRPD investigations were performed on dry samples, grinded by hand in agate mortar. Operative conditions of XRPD analyses were the following: CuK α radiation, 40 kV, 40 mA, 2 θ range from 4° to 70°, equivalent step size 0,017° 2 θ , 60s per step counting time on a modular Panalytical X'Pert Pro diffractometer equipped with a RTMS X'Celerator detector. The software for identification of mineral phases was Panalytical Highscore Plus 3.05 with ICSD database. Scanning electron microscopy (SEM) observations were performed on a JEOL JSM5310 instrument. Chemical analyses were obtained through energy dispersive spectrometry (EDS) on an Oxford INCAx microanalyser.

II. RESULTS

Natural stone materials

Regard tuff samples are very similar from macroscopic and microscopic point of view. Macroscopic observations show a cineritic texture formed by an ash-matrix with pumice, obsidian, mica, loose crystals of alkali feldspar (sanidine) and clinopyroxene (Fig. 3). Glassy shards and sometimes secondary calcite are also present.

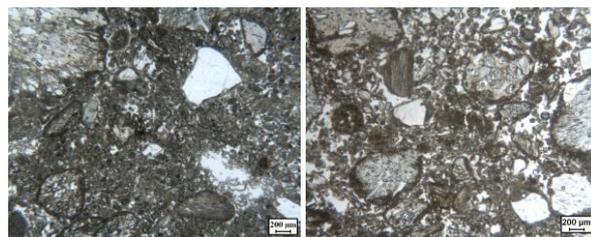


Fig. 3. Micrographs of representative tuff samples showing pumice, biotite, alkali feldspar and clinopyroxene.

XRPD analysis, along with authigenic minerals, also highlight the occurrence of different zeolites such as Phillipsite, Chabazite and Analcime. SEM-EDS analysis, performed on *juvenile* fragments (obsidian and pumice), showed a quite similar chemical composition with SiO₂ values ranging from 56 to 62 wt.% and Na₂O+K₂O between 11 and 14 wt.%.

The lava, mainly used for the *Via Domitiana's* pavement, shows a weakly porphyric texture formed by a few alkali feldspars and sodalite phenocrystals in a fine grain matrix consisting of alkali feldspar, clinopyroxene, olivine and opaque minerals (fig. 4).



Fig. 4. Micrographs of representative lava sample showing sanidine and subordinate clinopyroxene and olivine.

Among the latters, XRPD results revealed the occurrence of magnetite. Samples showed a certain chemical homogeneity; the composition allowed to classify these lavas as trachytes.

Carbonate rocks, mineralogically composed by calcite along with small amounts of dolomite, can be distinguished in three types.

The first type is a microcrystalline limestone (fig. 5a) with abundant fossils, the second one is a medium-fine grained limestone with frequent cracks (fig. 5b), and the third type is a saccharoidal marble with medium to large crystals (fig. 5c).

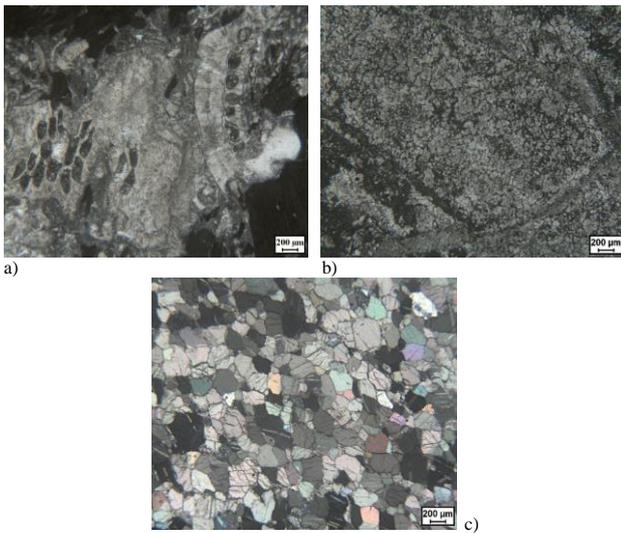


Fig. 5. Micrographs of fossiliferous limestone (a), micritic limestone (b) and marble (c).

Artificial stones

Mortars can be distinguished in coating (fig. 6a) and bedding (fig. 6b) ones, due to the presence or not of different layers, respectively. All mortars are lime-based with volcanic aggregates (sometimes along with pottery fragments) and manufactured according to Vitruvius recipe.

Thin section observations highlighted the presence of a carbonate matrix with different aggregates such as pumice, obsidian, alkali feldspar and smaller amounts of clinopyroxene, mica and quartz.

Plasters show the same mortars' carbonate matrix but a different kind of aggregate: volcanic fragments, pottery, limestone.

Once again, juvenile fragments were analysed with SEM-EDS showing a trachitic composition.

Cocciopesto is characterised by a carbonate matrix with both volcanic (pumice and obsidian) and ceramic fragments (fig. 6c).

Mineralogical analysis, as seen for tuffs, highlighted the presence of three different zeolites: Phillipsite, Chabazite and Analcime.

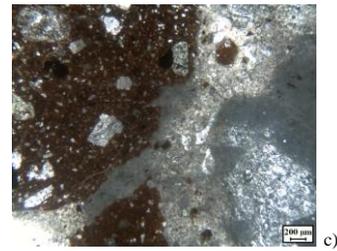
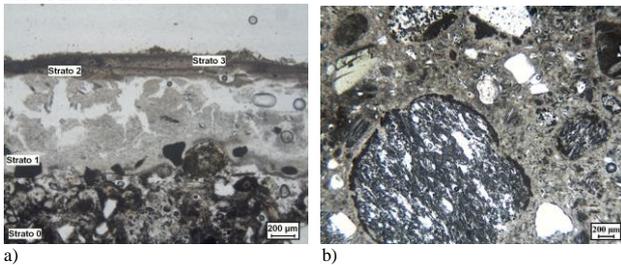


Fig. 6. Micrographs of coating mortar (a), bedding mortar (b) and cocciopesto (c).

III. DISCUSSION

Mineralogical and petrographical investigations carried out on geomaterials from this important archaeological site allowed us to formulate some hypothesis about their provenance.

As concern tuffs, the occurrence of Phillipsite, Chabazite and Analcime identify the outcropping area within Phlegrean Fields. Moreover, mineralogical results evidenced the strong affinity between collected samples and Neapolitan Yellow Tuff formation (NYT) ([6], [7], [8]).

The above assertion was also confirmed by results of microchemical analyses (EDS) performed on juvenile fraction (obsidian and pumice fragments). These data were plotted in the TAS diagram and fall in NYT field.

Also lavas' chemical composition shows high affinity with trachyphonolites outcropping in the Cuma area.

Mortars, plasters and cocciopesto, despite, their different function in sites' buildings were all characterised by the use of similar raw materials: volcanic aggregates, limestone, and ceramic fragments. As concern volcanic materials, EDS analysis on juvenile fraction also confirmed the Phlegrean provenance.

As concern carbonate rocks, they were chosen in function of the final destination, as limestones for structural elements and marble for decorative purposes. Although, no evidence allowed to identify the specific rock formation, at least for limestones can be hypothesized a local provenance, probably located in the Sorrento peninsula.

The marble represents the only geomaterial that not belongs to the Campanian geological context and probably coming from the burial of pre-existing buildings.

IV. CONCLUSION

This research provides new insights about geomaterials used during the Roman age in an important archaeological site such as the Cuma's necropolis. Mineralogical-petrographical investigations allowed to hypothesise the provenance area of geomaterials *s.s.* and *s.l.*

As regards volcanic geomaterials, they are related to the Phlegrean activity. In particular, tuffs are directly linked to Neapolitan Yellow Tuff deposit as inferred by the occurrence of the typical zeolites association: Phillipsite, Chabazite, Analcime.

Lava samples from *Via Domitiana's* pavement show petrographic affinity with the volcanic series outcropping in the area.

Limestones and marbles can be considered as the only imported stones. The first type used as a building material, while the second one favoured for architectural elements.

As regards artificial stones, mortars, plasters and *cocciopesto* samples, despite the different typology and abundance of aggregates, it is possible to hypothesize a Phlegrean origin also for the aggregate.

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