(Article begins on next page)

HORTUS ARTIUM MEDIEVALIUM, Luminosa Saecula / The Luminous Centuries. Lighting Systems in Churches Between Late Antiquity and the Middle Ages (eds. F. Stasolla, S. Panuzzi, M. David, M. Jurković), 2020, Vol. 26, p. 73-76

PROVENANCE OF THE TRANSPARENT GYPSUM CRYSTALS (*LAPIS SPECULARIS*) AND GYPSUM MORTARS IN THE WINDOWS FROM THE CHURCHES OF ROME: S. SABINA SULL'AVENTINO AND S. GIORGIO AL VELABRO

STEFANO LUGLI, MATTEO REGHIZZI, SIMONA PANNUZI

S. Lugli*, M. Reghizzi*, S. Pannuzi**

The latest example of the traditional Roman use of lapis specularis *crystals in windows panels instead of glass are represented by the Paleochristian-Early Medieval churches of Rome. The churches of S. Sabina sull'Aventino and S. Giorgio al Velabro were characterized by some of the most ancient examples of windows frameworks built using gypsum mortar. The light was penetrating the panels throughout openings covered by two or more embricated gypsum cleveage fragments less than 15 cm across and up to 7 mm-thick, a technique unknown in older Roman examples, which is clearly related to the availability of small and low-quality crystals. The petrography of the gypsum mortars and the strontium and sulfur isotope analyses of the crystals indicate two different supply sources. A large group of window frameworks were produced using selenite rocks and* lapis specularis *crystals probably quarried from Tuscany, Sicily or Cyprus, whereas a window in S. Sabina was built using alabastrine gypsum and* lapis specularis *crystals quarried in Emilia-Romagna, Sicily, Cyprus or Southern Turkey.*

Keywords: Lapis specularis*, gypsum, strontium and sulfur isotopes, gypsum mortar, Paleochristian-Early Medieval churches.*

INTRODUCTION

Italy has a large tradition, dating back from the Roman Age, for the use of transparent gypsum crystals instead of glass to cover the openings of windows panels. Pliny the Elder in his *Naturalis Historia* described the use of *lapis specularis* and their provenance from Spain, Italy, North Africa, Cyprus and Turkey. Some exquisite examples from Pompeii show spectacular transparency and large size of very thin cleavage plates, which are up to 27 cm across and less than 2 mm in thickness[1].

The use of gypsum crystals for windows was gradually abandoned in favor of glass, but in a few cases extended further also in the Paleochristian-Early Medieval age. The most important examples of the late use of *lapis specularis* are from the churches of S. Sabina sull'Aventino (V century CE) and S. Giorgio al Velabro (VII-VIII? Century CE) in Rome[2]. Even the frameworks holding the crystals were produced using gypsum mortar, and these seem to be the most ancient examples for such use in windows panels, which later became quite common in the Islamic world. Given the widespread historical source areas for gypsum in the Mediterranean basin, we performed a set of petrographic and geochemical analyses to determine the provenance of the crystals and of the raw material used for the window frameworks of the churches of Rome.

---

[1] C. GUARNIERI, S. LUGLI, M. S. PISAPIA, V. INGRAVALLO, D. GULLÌ, R. RUGGIERI, G. BUSCAGLIA, M. REGHIZZI, M. ERCOLANI, P. LUCCI, B. SANSAVINI, M. J. BERNÁRDEZ GÓMEZ, J. C. GUISADO DI MONTI, in press, Lapis specularis *a Pompei. Contestualizzazione archeologica e analisi isotopiche per la determinazione della provenienza: risultati preliminari,* in *Atti II Congreso internacional sobre la minería romana del lapis specularis*, Cuenca 2015.

[2] S. PANNUZI, this volume.

MATERIALS AND METHODS

We studied five fragments from the window frameworks made of gypsum mortar of the S. Sabina church: three from the larger group of window panels[3] (transenna 2, 3, 4 and 5) and one from the arched panel window from the apses (transenna 6). We prepared standard thin sections for the study under the optical microscope in transmitted light. Moreover, we performed strontium and sulfur isotope analyses[4] on a total of four *lapis specularis* fragments, three from the same windows previously described (transenna 3, 4 and 6) and an additional one from a window of the S. Giorgio in Velabro church.

THE GYPSUM MORTAR FRAMEWORKS

Description

The *lapis specularis* window panels of the churches of Rome appears to be among the first examples ever described of window frameworks produced using gypsum mortar. This is true also for the case of the well-studied Roman windows from Pompeii, where only wood, bronze, stone and occasionally fired-clay frameworks have been described[5]. The production technique for the churches in Rome is revealed by the observation of the cross section of the broken frameworks observed during the restoration process[6]. The frameworks are about 3.5 to 5 cm-thick and consist of a single structure and not two halves joint together (fig. 1). The structure was obtained by pouring a gypsum paste in a cast, which in the first phase was only half-filled. The crystals were then laid down on the gypsum paste above the windows openings, two or more overlapping crystals for each opening (see next section; fig. 2). A second gypsum paste load was then poured into the cast forming a single mortar structure firmly holding the transparent crystals in place in the middle of the openings[7] (fig. 3).
One side of the window panels is commonly characterized by the presence of dissolution features by rainwater, such as rain-pits (*kraterkarren*, fig. 4) located in the lower horizontal side of the openings. It follows that, even for disassembled windows keept in museums, it is always possible to recognize which side of the panel was originally facing the exterior of the window directly hit by rainwater and runoff.

Petrography

The window frameworks consist of gypsum mortar obtained by the dehydration of gypsum rocks into kilns. The composition of the underburnt fragments included into the mortars may help to determine the provenance of the rock. Transenna 2, 3, 4 and 5 show underburnt fragments of selenite (fig. 5a), whereas only transenna 6 shows underburnt rounded fragments of alabastrine rock containing also microcrystalline anhydrite rock fragments (fig. 5b). Alabastrine rocks containing anhydrite are

---

[3] S. PANNUZI, this volume.

[4] We thank A. Cipriani for facilitating Sr isotope analyses at the isotope laboratory at the University of Modena and Reggio Emilia.

[5] V. INGRAVALLO, M. S. PISAPIA, *Trasparenze antiche dalle città Vesuviane: frammenti di lapis specularis da Pompei e da Ercolano* in C. GUARNIERI (a cura di) *Il vetro di pietra. Il lapis specularis nel mondo romano dall'estrazione all'uso*, Faenza, 2015, pp. 161-168.

[6] S. PANNUZI, *L'utilizzo del* lapis specularis *nelle transenne di finestra delle chiese romane: il caso della basilica di Santa Sabina sull'Aventino*, in *Atti III Convegno internazionale*, *Il lapis specularis nei rinvenimenti archeologici*, Brisighella 2017. in press.

[7] S. PANNUZI, this volume.

present in the Late Miocene of Tuscany, Sicily and in some parts of Romagna. These type of rocks are present also in Turkey.

THE *LAPIS SPECULARIS* CRYSTALS

Description

In the churches of Rome each opening of the window framework was covered normally by two or up to five crystal cleavage irregular fragments, about 5 to 7 mm-thick, which were partly overlapping, forming an imbricated structure in the vertical direction to prevent rainwater from entering the window. Because some of the openings, from where the light was penetrating the church, were up to 23 cm long and 6-7 cm wide, the production technique suggests that only relatively small crystals were available and the artisans were forced to create a composite patchwork using different overlapping crystals (fig. 1 and 2). The largest irregular crystal that we were able to measure during the restoration works reaches 15 cm across and has a trapezoidal shape. The crystals are relatively small compared to those discovered in Pompeii[8] (up to l7 cm across and less than 2 mm-thick) and compared to the maximum size, which was possible to carve out of the Roman *lapis specularis* mines in Spain, for example, with crystals up 50 cm across[9].
As previously described for the mortar frameworks, also the *lapis specularis* crystals show dissolution features only on one side.
For their small size and relatively low transparency, the crystals from the churches of Rome were surely not a first choice. In addition, their relatively large thickness also indicates that the crystals were not easy to split in thin cleavage plates because partly deformed and not perfectly planar. Their uneven cleavage surface was also the reason for a lower transparency compared to the most prestigious examples from Pompeii. Some crystals show also a distinct pale yellow color, which is detrimental of the general quality and is typical of some *lapis specularis* crystals from the quarries of Emilia-Romagna, Tuscany and Sicily. All these macroscopic characteristics taken together appear to exclude the most prestigious sources described by Pliny the Elder in central Spain and central Turkey and seem to point to local, Italian sources for the crystals.

Isotope geochemistry

We have shown that the combination of strontium and sulfur isotopes may provide fundamental insights on the provenance of *lapis specularis* in the Mediterranean basin[10]. This because gypsum from different areas in the region have different isotopic signatures, with the exception of some partial overlapping of the composition fields (fig. 6). The only uncertainty of this methodology is that,

---

[8] S. LUGLI, M. REGHIZZI, M. ERCOLANI, P. LUCCI E B. SANSAVINI, *Il lapis specularis a Monte Mauro: la più grande concentrazione di cave romane fuori della Spagna,* in *I gessi di Monte Mauro, studio multidisciplinare di un'area carsica nella Vena del Gesso romagnola*, M. COSTA, P. LUCCI, S. PIASTRA (a cura di), *Memorie dell'Istituto Italiano di Speleologia*, s. II, v. 34, 2019, p. 583-595.

[9] S. LUGLI, M. DIAZ-MOLINA, M. I. BENITO MORENO, R. RUGGIERI, V. MANZI, *Giacitura e origine dei cristalli gessosi di lapis specularis nell'area mediterranea*, in C. GUARNIERI (a cura di) *Il vetro di pietra. Il lapis specularis nel mondo romano dall'estrazione all'uso*, Faenza, 2015, pp. 205-210.
[10] S. LUGLI, M. REGHIZZI, A. CIPRIANI in press, *Analisi isotopiche per la determinazione della provenienza di lapis specularis,* in *Atti III Convegno internazionale, Il lapis specularis nei rinvenimenti archeologici,* Brisighella 2017.

unfortunately, *lapis specularis* mines in Turkey and Cyprus have not been discovered yet and the only available isotope data regard the host gypsum rock. Because the *lapis specularis* have a secondary origin, they received their isotopic signature from the host gypsum rock. It follows that the isotopic values of *lapis specularis* should be similar to those of the host rock. Using this methodology we were able to demonstrate that the exquisite *lapis specularis* crystals from Pompeii were quarried either from Cuenca (Spain) or Cappadocia (Turkey). Supply sources in Italy, Cyprus, southern Turkey and Southern Spain could certainly be excluded[11].
The results from the churches of Rome show completely different provenance areas than the crystals from Pompeii. The isotope values of the crystal from S. Giorgio in Velabro is within the composition field of Sicily, Tuscany and Cyprus. The crystals from transenna 3 and 4 of S. Sabina are plotting outside the main compositional fields, but near the composition fields of Sicily, Tuscany and Cyprus. The *lapis specularis* of transenna 6 from S. Sabina shows very different values from the other crystals. According to our general provenance scheme, they could have been quarried in Emilia-Romagna, Sicily or Cyprus.

CONCLUSIONS

The integrated study of *lapis specularis* used for the window panels of the Paleochristian and Early Medieval churches of S. Sabina sull'Aventino and S. Giorgio al Velabro in Rome indicates that the crystals are very different from those used in Pompeii. The Roman city destroyed by the eruption of the Vesuvius in 79 CE is characterized by exquisite examples of large and thin crystal plates coming from the most celebrated mines described by Pliny the Elder in Cuenca (Spain) and Cappadocia (Turkey). These famous localities are excluded for the churches of Rome by the results of our geochemical analyses. These results are corroborated by the fact that the crystals are small, thick, not perfectly transparent and affected by a faint yellow tinge. For these reasons they can be classified as low quality, second choice, which is compatible to all the *lapis specularis* quarries that we have described in Italy (Emilia-Romagna and Sicily).
The petrographic and isotope analyses show that the windows panels were produced using two different types of gypsum mortars holding two different types of *lapis specularis* crystals. The larger group of windows from S. Sabina sull'Aventino have the same mortar structure derived from the dehydration of selenite rocks and a *lapis specularis* geochemical signature similar to the S. Giorgio in Velabro example. The provenance of the crystals was from Tuscany, Sicily or Cyprus. Only transenna 6 from the apses of S. Sabina sull'Aventino shows a different mortar composition related to the burning of an alabastrine rock and a different isotopic signature for its *lapis specularis*, which is compatible with a provenance from Emilia-Romagna, Sicily, southern Turkey or Cyprus.

[11] *Ibid*.

Figure captions

Fig. 1. Side view of a cross section through a window showing two embricated crystals of *lapis specularis* included into the gypsum mortar framework. Transenna 6 from S. Sabina church before restoration.
Fig. 2. Front view of a window panel showing imbricated *lapis specularis* crystals included into a gypsum mortar framework. Transenna 4 from S. Sabina church before restoration.
Fig. 3. Window panel mortar frameworks from the S. Sabina church: A) side view of a broken fragment showing the cross section through transenna 4 produced by dehydration of a selenite rock, and B) front view of the lower side of transenna 6 produced by dehydration of an alabastrine rock. See fig. 5 for a view under the optical microscope.
Fig. 4. Rain-pits dissolution features on the external side of transenna 4 from S. Sabina church after restoration. Notice the thick *lapis specularis* fragment engulfed within the gypsum mortar.
Fig. 5. Photomicrograph of gypsum mortar frameworks from S. Sabina church illustrated in fig. 3: A) transenna 4 showing underburnt fragments of selenite rock (gray-colored corroded fragments in the upper and lower right corners) and B) transenna 6 showing large rounded fragments of alabastrine rock (upper side) and anhydrite rock (center and lower right side). Optical microscope, transmitted light, crossed polars.
Fig. 6. Plot of the *lapis specularis* samples from S. Sabina and S. Giorgio in Velabro churches within the general Sr and S isotope fields for *lapis specularis* and gypsum rocks of the Mediterranean area.

fig. 1

fig. 2

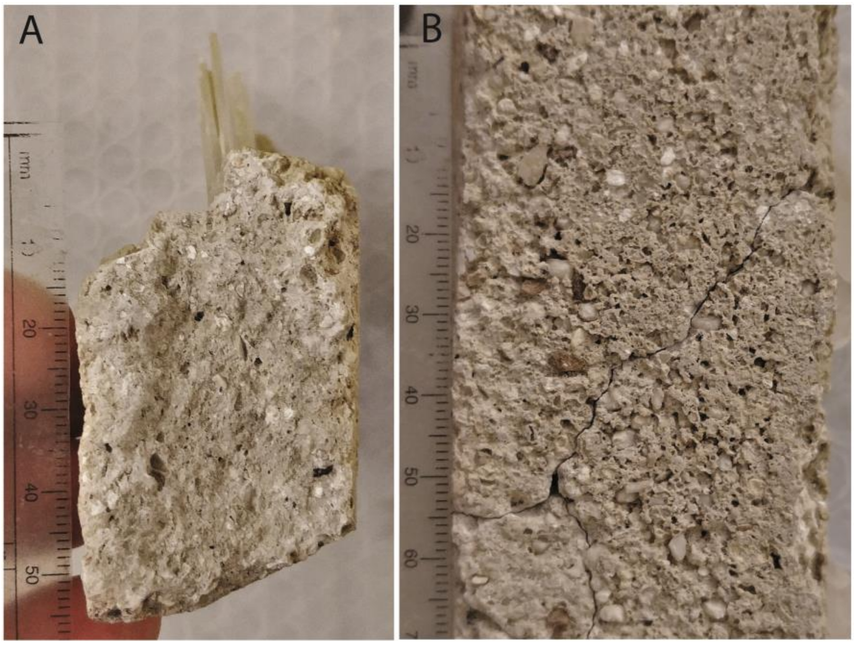
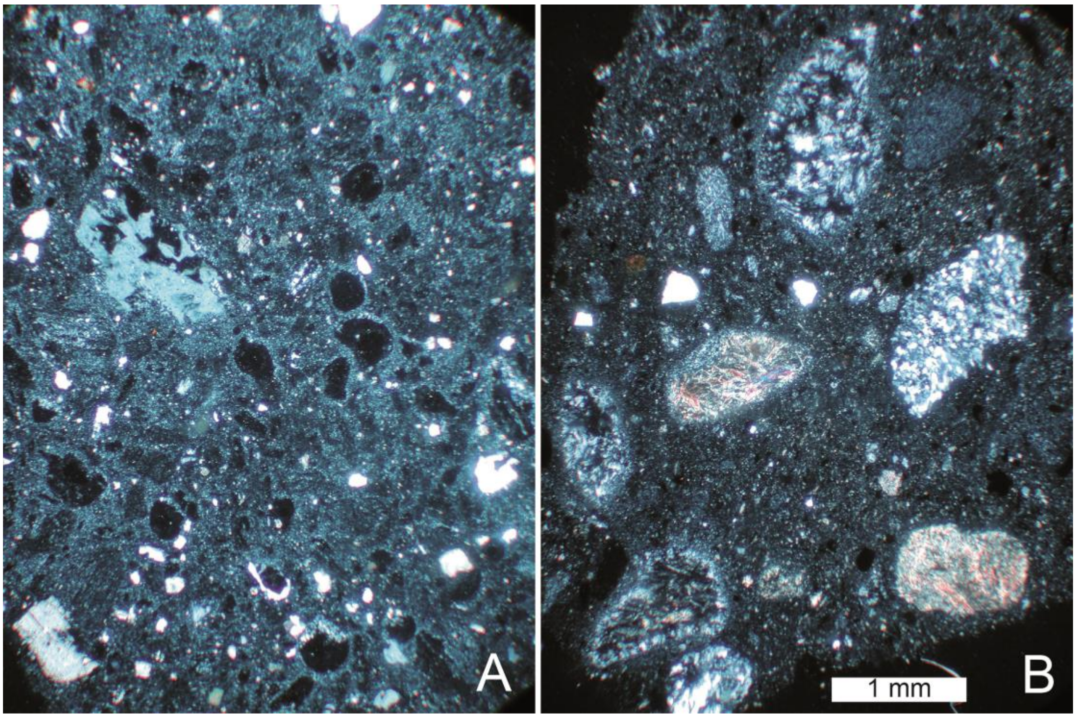


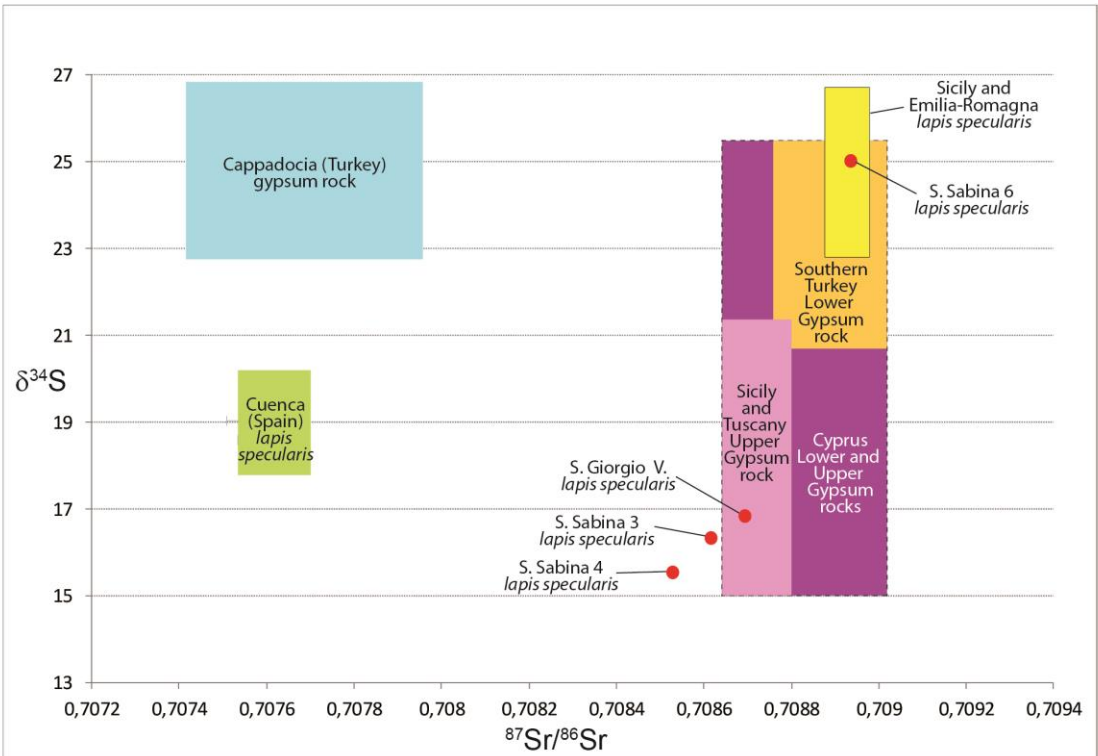
fig. 3


fig. 4



A
1 mm
B

fig. 5



27
25
23
21
19
17
15
13
δ34S
0,7072
0,7074
0,7076
0,7078
0,708
0,7082
0,7084
0,7086
0,7088
0,709
0,7092
0,7094
87Sr/86Sr
Cappadocia (Turkey) gypsum rock
Cuenca (Spain) lapis specularis
Sicily and Emilia-Romagna lapis specularis
S. Sabina 6 lapis specularis
Southern Turkey Lower Gypsum rock
Sicily and Tuscany Upper Gypsum rock
Cyprus Lower and Upper Gypsum rocks
S. Giorgio V. lapis specularis
S. Sabina 3 lapis specularis
S. Sabina 4 lapis specularis

fig. 6