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CHARACTERIZATION AND PROVENANCE OF MARBLE CHANCEL SCREENS, NORTHERN JORDAN

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ABSTRACT

This research characterizes marble chancel screens and their supporting columns, confiscated from treasure thieves, probably from northern Jordan in order to manage the most fruitful conservation and restoration interventions for them. It provides new archaeometric data and determines the probable source of the marbles. The results of mineropetrographic, X-ray diffraction and carbon and oxygen stable isotope analyses show that the marbles most probably are Proconnesian-1. The results agree with the historical records supported by archaeometric analyses that Proconnesos marble was widely used during the Roman and Byzantine periods for architectural purposes. The results suggest that color style of Proconnesian marble astonished the Byzantine stonemasons and architects thus have been widely used.

KEYWORDS: marble, chancel screen, Jordan, oxygen and carbon stable isotopes, maximum grain size, grain boundary, Byzantine, XRD, Proconnesian, Thasos

INTRODUCTION

Marble is one of the most valuable stones used in antiquity. Romans and Byzantines extensively used marble in their buildings and monuments. They transported large quantities and blocks of marble from ancient Mediterranean quarries to most Near Eastern archaeological sites (Capedri *et al.*, 2004). Byzantine architecture is rich in colored decorative elements and characterized by large domes, round arches, elaborated columns, and a wide use of marble (MacDonald, 1962; Hutter, 1988). During the Byzantine Period in the Near East, spread of Christianity, economic prosperity and demographic stability lead to the construction of many churches (Lucke *et al*., 2005; Qaqeesh, 2007). The interior design of Eastern Christian churches separated the sanctuary from the nave by icon screens or iconostasis. Marble, among other materials, has been used to make such screens during the Byzantine Jordan. Excavations of Byzantine churches at Petra, Umm el-Rasas, Rihab, Humayma, Umm Qais, Abila and Capitolias revealed marble screens of simple slabs decorated with crosses in a bas-relief.

The Archaeometry Laboratory at the Faculty of Archaeology and Anthropology at Yarmouk University received four similar rectangular marble chancel screens badly restored by polyester resin and six columns for restoration and conservation (see figure 1). Conservation and repair processes of the screens and columns require proper analysis to ascertain exactly what material was used and demands a detailed understanding of materials currently available. Knowledge of the correct provenance of the marbles under investigation is necessary for the selection of identical marble for substitution, conservation and repair.

In our region and during the Roman and Byzantine Periods, Proconnesian (Marmara) marbles were widely used for architectural elements (Al-Bashaireh, 2003; Fischer, 2003). They share with other marbles macroscopic features such as medium to large grain size and strong sulfur odor upon scraping or grinding, but they are highly characterized by regular grey banding. Several databases on Mediterranean marbles (including Proconnesos) based on carbon and oxygen isotopes and other techniques have been published, for instance see Herz (1987), Moens *et al.*(1990), Asgari and Mathews (1995), Gorgoni *et al.*(2002), Polikreti and Maniatis (2002), Attanasio (2003), Capedri *et al.* (2004) and Attanasio *et al.* (2006).

The chancel screens we received at Yarmouk laboratory have grey bands, therefore it is probable that Proconnesos is their source. However, Marmara region is more than 40 square kilometers and has more than 23 quarries (Asgari and Matthews, 1995; Attanasio *et al.*, 2008a,) therefore it is of great importance (if possible) to allocate a specific quarry for the samples. Asgari and Matthews (1995) recognized Proconnesian marbles with highly negative $\delta^{18}O$ values. Gorgoni *et al*. (2002) confirmed these results and called them Proconnesos-2. Although Proconnesos-2 marbles were not widely used during Roman and Byzantine periods (Asgari and Matthews 1995, Attanasio *et al*., 2008a), Al-Bashaireh (2003) found that they were used for some architectural elements to build the ancient city of Gadara (Umm-Qais), Northern Jordan. We attempt in this work to figure out the source of these screens and columns, determine if they are of Proconnesos-1 type or Proconnesos-2 type and assign a specific quarrying location at Marmara for them.

In some cases it is difficult to differentiate between Thasian and Proconnesos marbles by color only (see Attanasio *et al*., 2008b). Thasian marbles used in carving chancel screens of the two churches at Latrun (Cyrenaica, Libya) were misidentified with Proconnesian marbles because of their similarity in color (Attanasio *et al.*, 2008b). Sodini (1989), who found in the double church at Aliki, on Thassos, architectural elements of similar design, argued that the Thasian stonemasons in the 6th century might have been imitating the Proconnesian style. Attanasio *et al*. (2008b) differentiated between them successfully using scientific methods and found a strong correlation between provenance and type of the architectural element sampled; Thasian marbles at Latrun were used exclusively for the manufacture of chancel screens, while Proconnesian marble was used for architectural elements. They proposed that the use of different materials is related to the ability of certain workshops to supply specific marble fittings either cheaper or of better quality. We also attempt in this study to report new characteristic data and examine the exactness of the model proposed by Attanasio *et al*. (2008b) suggesting specialized Thasian quarrying for chancel screens.

Provenance of ancient marbles has been determined by several methods including trace elements (Conforto *et al.,* 1975), cathodoluminescence (Lapuente *et al.,* 2000), electron paramagnetic resonance (Attanasio *et al.,*, 2008b), strontium isotopic distribution (Brilli *et al.,* 2005), but oxygen and carbon isotopes and mineropetrography are often used, (Craig, 1972; Manfra *et al.,*, 1975; Kempe and Harvey, 1983; Herz and Dean, 1986; Herz, 1987 and 1992; Dean, 1988; Moens *et al.,*, 1989, and 1990; Gorgoni *et al.,*, 2002).

MATERIALS AND METHODS

Two of the abovementioned screens were damaged, while the other two were almost unharmed. The columns were used to support the screens. The screens and the columns were carved in white marble of light grey bands. Unlike most marble screen forms excavated in Jordan, each screen was segmented into 15 jointed sectors decorated with leaves and flowers of different shapes. They do not have crosses in relief, but the decorated segments formed the crosses. The screens are 125cm in length, 88cm in width, and 6cm in thickness (see figure 1). Unfortunately, the exact context of the screens and the columns is unknown; they were confiscated from treasure hunters. However, it is believed that they were robbed from the archaeological site of Capitolias (Beit Ras) or of Abilla (Queilbeh), both in north Jordan.

Nine samples were taken from the chancel screens and columns. Six samples from two opposite rear diagonal corners or already damaged parts of three screens and three samples from the ends of three columns were collected, see figure 1. Sampling strategy aimed to obtain representative portions and to keep the aesthetic appearance of the screens and the columns unaffected.

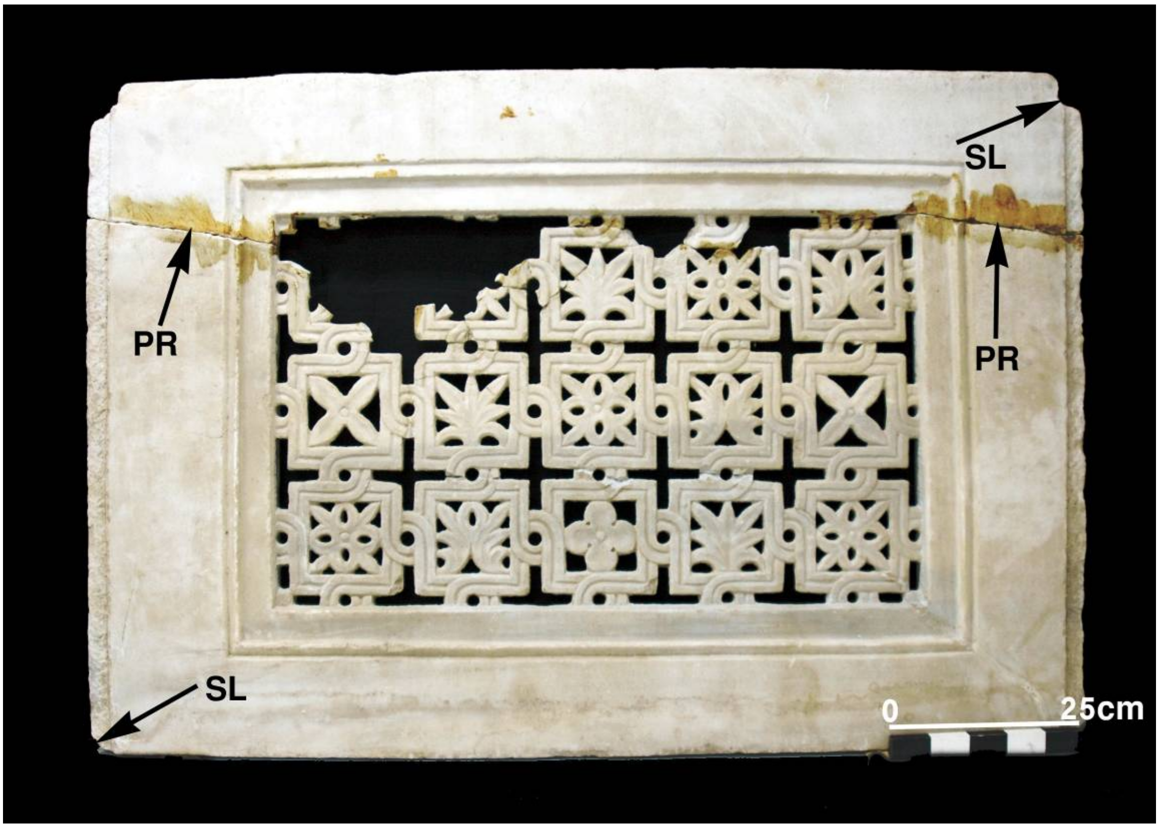


Fig. 1: shows the damage in one of the screens, the remains of polyester resin (PR) and samples locations (SL).

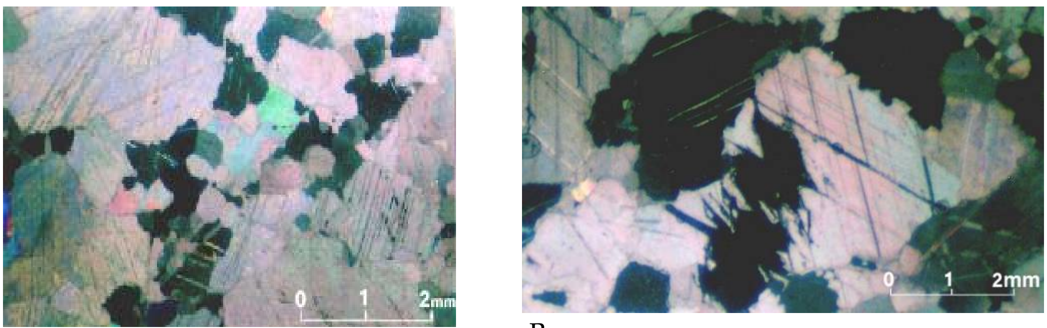
Petrography, XRD, and stable Carbon and Oxygen isotopes were applied to characterize the marbles. The results of these analyses were compared to the main reference databases for Proconnesos marbles (Asgari and Mathews, 1995; Capedri *et al*., 2004; Attanasio *et al*., 2008a) and for the main Mediterranean marbles used in antiquity (Moens *et al*., 1988; Gorgoni *et al*., 2002).

Thin-section examinations by Leica DMLSP polarizing microscope were used to identify a number of petrographic parameters with important diagnostic significance for marble including fabric, maximum grain size (MGS) of calcite or dolomite grains and their boundary shapes (Lazzarini *et al*., 1985; Moens *et al*., 1988; Gorgoni *et al*., 2002 and Gaggadis-Robin *et al.*, 2003). Thin sections were made in the Archaeometry lab of the Faculty of Archaeology and Anthropology at Yarmouk University, photomicrographs under Cross Polarized Nichols (XPL) were taken by a camera attached to the microscope. The data thus obtained were supported by XRD which was carried out on powdered samples using a Shimadzu Lab X, 6000 X-Ray Difractometer available at the Faculty of Archaeology and Anthropology at Yarmouk University. Trace minerals were also detected by XRD on powders treated with 10% HCl acid in order to concentrate them by dissolving calcareous minerals of the samples mainly calcite, considering that dolomite dissolves slower than calcite in acid (Lewis and McConchie 1994). Powder diffraction patterns were obtained under the following conditions: CuK$\propto$ radiation (1.5418 Å) with 30 kV, 30 mA energy and Graphite Monochromatic.

The isotopic analyses were carried out using a Finnigan Mat Delta E mass spectrometer at the Water Authority of Jordan, Amman (WAJ). The CO_2 extracted from carbonate samples by reaction with 100% H_3PO_4 at 25°C was measured for $^{13}C/^{12}C$ and $^{18}O/^{16}O$ ratios. The results were expressed in terms of $\delta^{13}C$ or $\delta^{18}O$ and measured in parts per mil (‰) relative to the international reference standard PDB (Faure, 1986).

RESULTS AND DISCUSSION

Microscopic features of the samples studied in thin sections show that the maximum grain size (MGS), a diagnostic feature for discriminating marbles, of calcite grains is about 3.5mm. This medium MGS distribution is typical of marbles from different localities (Aphrodisias, Proconnesos, Thassos, and Paros) (Moens *et al.*, 1988; Gorgoni *et al.*, 2002). The samples are heteroblastic (i.e. formed of calcite grains of different sizes) forming a mortar fabric, typical of Proconnesos marble, made of coarse grained calcite of deformed twining lines surrounded by fine grained calcite (0.7-0.8 mm) (see figure 2). The boundaries of the coarse crystals are sutured to embayed (i.e grains are interlocked) indicating a non-equilibrated metamorphic conditions. The mortar fabric of the samples with sutured boundaries and deformed twining lines exclude Paros 2-3 provenance. Thassos-1-2-3 sources can also be excluded; historical records state that Thassos-1-2 marble distribution was very limited in the Romans Imperial Times especially for decoration purposes (Gorgoni *et al*., 2002), while Thassos-3 is mainly dolomitic and was mainly used for statues (Herrmann and Newman, 2002).



A B

Fig. 2: Photomicrograph (XPL) A- mortar fabric, B- sutured boundaries.

The results of carbon and oxygen isotopic composition, presented in table 1, are reported graphically in the C-O correlation diagram of figure 3, where they can be compared to the isotopic fields of the main databases of Mediterranean marble quarries used in antiquity. The position of the samples, located in an overlapping reference fields in the diagram, pinpoints only four sources for the studied marbles: Carrara, Thassos-(1,2), Paros-(2,3) and Proconnesos-1. These results are highly significant; they exclude Aphrodisias and Thassos-3 sources, but show that Proconnesos-1 (in addition to Carrara, Thassos-(1,2) and Paros-(2,3)) is a probable source for the marbles.

Sample 3 and sample 8 are located within Paros 2-3 isotopic field, but just at the border of the Proconnesos-1 isotopic field. It is important to note that when the database established by Gorgoni *et al*. (2002) is used, these two samples will be located within Proconnesos-1 isotopic field of the C-O isotopic diagram. Gorgoni *et al*. (2002) suggested enlarging the isotopic field of Proconnesos-1 in order to comprise the new isotopic values of Proconnesos-1 marbles they studied. The isotopic and mineropetrographic results support the need for the enlargement of Proconnesos-1 isotopic field.

However, the results disqualify Proconnesos-2 to be a possible source for them. Carrara marble is excluded because it is white fine grained (MGS=1.5mm) (Moens *et al.*, 1988; Gorgoni *et al.*, 2002) and free of Kaolinite as trace minerals, while the studied samples have Kaolinite (fig. 4B).

Oxygen isotope values of the samples are lowly negative (see table 1). Comparing oxygen isotope values in table 1 to those given by Asgari and Matthews (1995), they match the oxygen isotope values of Silinte (Harmantas) and some values of the Necropolis areas. All of Silinte quarries have similar depressed negative oxygen isotope values, but only one value from southwest Silinte is more negative (-3.17‰) than the rest of Silinte quarries. On the other hand, they appear in the range of only three oxygen values out of six values from Necropolis.

Sample	$\delta^{13}C$‰ ± 0.20	$\delta^{18}O$‰ ± 0.15
1*	3.52	-0.41
2*	2.45	-0.46
3**	1.93	-0.19
4*	3.4	-0.49
5*	2.8	-1.05
6*	3.56	-0.41
7*	3.39	-0.44
8**	1.78	-0.38
9**	3.5	-0.42

Table 1: carbon and oxygen isotopic composition of the samples (*: screens and **: columns).

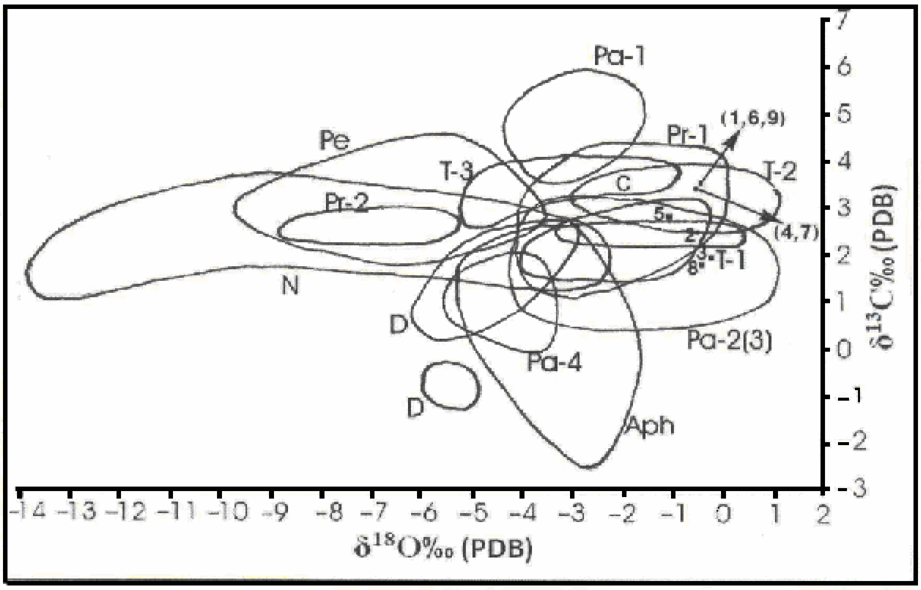


Fig. 3. Position of the isotopic values of the samples in $\delta^{18}O$–$\delta^{13}C$ reference diagram for the main Mediterranean marble quarries. T: Thassos (T-1: Fanari district; T-2: Aliki district; T-3: Vathy-Saliara district); D: Dokimion (Afyon); N: Naxos; Pa: Paros (Pa-1: Lychnites variety; Pa-2: Chorioudaki valley; Pa-3: Aghios Minas valley); Pe: Penteli; C: Carrara; Pr: Proconnesos (Marmara) (after Capedri and Venturelli, 2004).

X-ray diffraction results show that the samples before acid treatment are mainly composed of calcite and quartz (figure 4A), while more minerals were identified after HCl treatment, i. e. dolomite, mica, orthoclase and kaolinite (figure 4B). Dolomite is of poor diagnostic significance in discriminating marble sources since traces of dolomite are present in almost all Mediterranean marbles, but Paros. These results provide another reason to exclude Paros marble as a source for the samples.

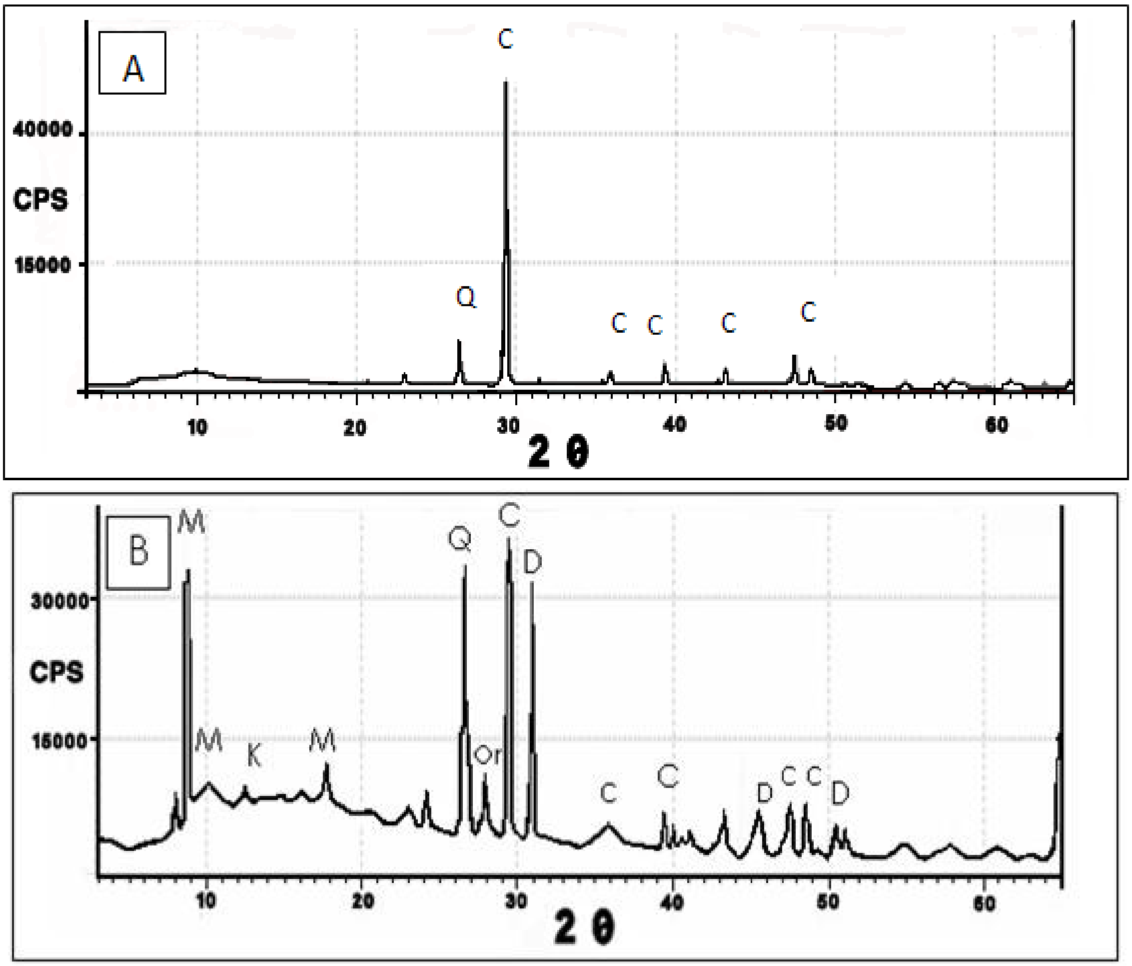


Fig. 4: XRD pattern of A- samples before acid treatment, B- samples after acid treatment. C: calcite, D: dolomite, Or: orthoclase, M: mica, Q: quartz, K: kaolinite.

On the contrary, the presence of Kaolinite which is of high significance in discriminating marble sources (Capedri and Venturelli, 2004). The presence of Kaolinite points to Proconnesos, Dokimion or Naxos. Microscopically Naxos and Dokimion marbles can be excluded; Naxos marble is very coarse grained, while calcite crystals of Dokimion marble are lineated, foliated, and fine sized (Gorgoni *et al.,* 2002). It is worth mentioning that traces of mica minerals (such as margarite, paragonite and phlogopite) were used to discriminate marble, but neither polarizing microscope nor X-ray diffractometry used in this research can differentiate between them, therefore the presence of micas can not contribute to the determination of the provenance of the studied samples in this research.

CONCLUSIONS

Analytical results illustrated that Proconnesos-1 is the most probable source for the studied screens and columns. Restoration of the screens and columns should be done using Proconnesos-1 marble, preferably from Silinte (Harmantas) or less likely from Necropolis. To the best of our knowledge this is the first study in Jordan to characterize marble chancel screens which provide more evidence that Proconnesos marble was widely used for architectural elements during the Byzantine period. The results may indicate that the use of Thasian marble to manufacture the chancel screens of the two churches at Latrun (Cyrenaica, Libya) are an exception of this historical data. Libya and Jordan belong to two different geographic regions; so the archaeological site of Latrun, Libya might have higher economic potentials or easier access to Thasian marble than the north Jordanian archaeological sites during the Byzantine period. In addition to the short distance between marble quarries and shipping centers, the availability of large blocks of marble and the presence of a large number of workers for finishing marble blocks (De Nuccio *et al.*, 2000 and Al-Bashaireh, 2003), the enormous use of Marmara marble in architecture may be attributed to its style and grey bands that amazed stonemasons and architects. The results agree also with Gorgoni *et al.* (2002) who suggested enlarging the main reference isotopic field of Proconnesos-1.

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