STUDY OF PROVENANCE OF THE ROMAN SARCOPHAGUS KNOWN TODAY AS THE TOMB OF KING RAMIRO II OF ARAGON

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Abstract

The paper shows the analytictal results obtained from the archaeometric study carried out on a Roman sarcophagus, known today as the tomb of King Ramiro II of Aragon, called "the Monk". Non-destructive spectrophotometric colour testing, petrography, cathodoluminiscence (CL microfacies and quantitative CL) and C-O isotopic techniques were applied in order to investigate its marble provenance. The characterization is based on available data of the most important ancient quarries around the Mediterranean Sea and the nearest French Pyrenean districts. The results prove the use of Proconnesian marble from Marmara Island in Turkey.

Keywords

Marble, Roman sarcophagus, Osca, archaeometry, Proconnesos, Marmara.

Introduction

The city of Huesca (North of Aragon, Spain) was inhabited at the beginning of the 2nd century BC, under the name of Bolskan, which is well documented by its silver and bronze coinage. During the Roman period it was renamed and became the *municipium* Urbs Victrix Osca. No Roman monuments are preserved today, given the bad quality of local soft miocene sandstone which was widely used, along with a general recycling of materials during the Medieval, Islamic and Christian, ages. To date, scarce pieces of marble, all from distant quarries, have been found in archeological works.

The Roman sarcophagus, known today as the tomb of the Aragonese King Ramiro II, is the best conserved and the largest element of marble currently located in Huesca. It is carved in white rock and measures 1.74 x 0.50 x 0.45 m. No information exists regarding its archaeological finding and original location. In addition, whether the piece was sculptured for an important person of the Roman Osca or was transferred from elsewhere during the Middle Ages is not known.

For centuries, the sarcophagus has been embedded in the wall of a chapel at the cloister of the romanesque church of San Pedro el Viejo (Saint Peter the Old), showing only its face. The richly carved front displays a strong coloration and an unusual shine (Fig. 1). A visual examination of this front showed the presence of a superficial patina, the result of the application of some pigmented wax that gives a brownish hue. Due to this unusual colour and through a previous lack of analytical tests, it was suggested that it was carved in gypsum alabaster from Aragon (Del Arco 1945).

The sarcophagus is presided, inside a circular medallion, by the togated bust of the supposed first user, for whom the piece was carved. The medallion is supported by two winged genies. In the lower center, is a full basket of fruits and two people half lying. The bearded man is holding a branch and the woman a cornucopia. The carving is completed by two small naked male figures standing on both sides, who are respectively playing an aulos and a lyre.

Several authors, cited by Del Arco (1945) suggest that the sarcophagus was found near its current location due to the general presence of Roman pottery and other artefacts in the ground. The author emphasizes, for some unknown reason, that the piece is a local copy carved in alabaster, of a Roman model of the beginning of the 3rd century. Hernández-Vera and González-Blanco (1981) made a detailed study on the iconography and a very meticulous comparison with more than twenty pieces of different collections, mostly in Italy, with the same decorative outline. Using stylistic reasoning, they dated the piece, as being from the end of 3rd century AD. Another sarcophagus, with the same chronology and style has recently been seen at an itinerant exhibition of the Spanish Archaeological National Museum.

Due to its wealth and beauty, the sarcophagus was reused as a royal tomb for the corpse of Ramiro II "the Monk" (April 24th, 1086 - August, 16th 1157). This monarch, the brother of the Kings Pedro I and Alfonso I of Aragon, had a rather peculiar reign. Destined to religious life in his youth, he should accept the royal dignity when his brothers died without heirs. He put down several rebellions of his knights, with the execution of twelve at the episode known as "Huesca's bell". He married the widow Ines of Poitou for convenience in November, 1135. Petronila, his only daughter, was born in June, 1136. Several months later, the marriage dissolved. The princess, being one year old, was promised to marry Ramón Berenguer IV, the count of Barcelona. At the end of 1137, he returned to ecclesial life but retained his royal dignity until his death.

Sampling

Taking advantage of the exhumation of the monarch´s remains for a DNA study, we proceeded to sample a small chip of an inconspicuous area of the sarcophagus. Having been embedded in the wall, only a small cavity on the top of the lid was accessible (Fig. 2).

Fig. 1. Front of the sarcophagus.

Fig. 2. Sampling operation.

Fig. 3. The interior surface of the sarcophagus is covered by a thin layer of lime. The sampling area was the top edge of a vertical fracture.

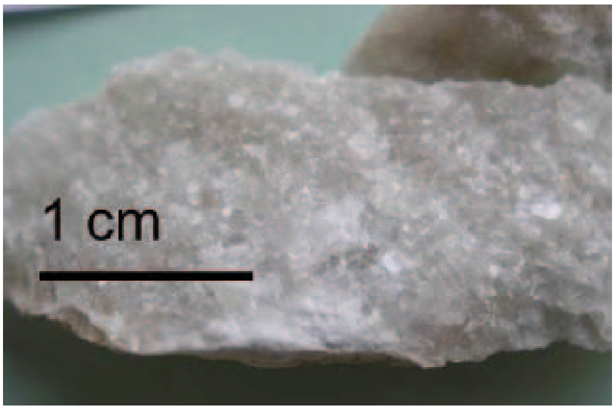

Fig. 4. Sample under study. Note the white colour with gray shades.

Fig. 5. Parallel grayish blue to gray bands visible in the transverse wall.

The interior was inspected under a flashlight but the observation revealed no textural or colour change in the stone. It was noted that the back wall was fragmented with a vertical fracture. The top edge of the break was selected to remove a small sample with a hammer and chisel (Fig. 3).

The chip, a few millimeters thick and about 4 cm long (Fig. 4), presented a white colour with gray shades and a relatively coarse grain size (> 2mm) of carbonate crystals. A remarkable feature of this marble was its fetid odour when it was fragmented.

Several months later, the sarcophagus was drawn out to proceed with its restoration and advantage was taken to observe the rest of its walls. It was found that the piece of white marble had parallel grayish blue to gray bands, which run lengthwise, only visible in one of the transverse walls (Fig. 5), while the other had been sectioned cutting the initial length of the sarcophagus.

Methodology

A multi-technique approach was used to determine the marble provenance. Automatic colour measurement, thin section microscopy, cathodoluminescence (CLmicrofacies and quantitative CL), and stable isotope analysis were applied to identify its quarry origin.

The index of whiteness (WI), CIE X, Y, Z, x, y values and CIELAB colour space values L*, a*, b* were automatically calculated on the matt finish surface of the sample using a portable Minolta CM-2600d spectrophotometer. Colour parameters, in reference to illuminant D65 and 2º observer, were measured according to CIE n.15, ISO 7724/1, ASTM E1164 and DIN 5033 specifications.

The polarizing microscope was systematically used for studying mineralogy and texture parameters. Particular attention was paid to fabric and grain size, measuring maximum grain size (MGS) and describing boundary grain shape (BGS). These parameters have a particular diagnostic significance for marble discrimination.

Cathodoluminescence analysis (CL) was carried out using CL8200 Mk5-1 equipment coupled with a NIKON Eclipse 50iPOL optical microscope[1]. The electron energy applied to the thin-sections was 15-20 Kv and the beam current was operated at 250-300 μA. The observed CLmicrofacies was registered onto a digital photograph using an automatic digital NIKON COOLPIX5400 camera.

A cathodoluminescence accessory for the scanning electron microscope (CL+SEM) was used to register the CL emission spectrum and to measure the characteristic peak intensities of the sample. This device (Zeiss Supra 55 VP) consists of a parabolic mirror as a collector, coupled to a Triax of Jobin&Yvon (with a LNT cooled CCD) grating spectrometer. The system is able to perform from 250 to 1200 nm. The CL emission intensities were noted at 375nm and at 620nm, registering 10 spectra every second, on three places of the same compressed powder, and normalizing to Céret marble which is 1000 units.

Oxygen and carbon isotopes were determined on the calcitic marble sample by isotope ratio mass spectrometry with Finnigan MAT 252 equipment. A Finnigan MAT Kiel II automatic preparation device was previously used for phosphoric acid digestion at 72ºC and CO_2 purification. The results were expressed in terms of usual delta notation ($\delta^{13}C$ and $\delta^{18}O$) in ‰ relative to the international reference standard PDB.

Provenance determination was carried out using a sequential approach, taking into account colour parameters, petrography and CLmicrofacies as the first step. Complementary techniques were used to verify the determination.

Results

The macroscopic peculiarities observed, especially the grey to bluish parallel bands, regularly distributed in the medium-coarse grained white marble alongwith its fetid odour are very distinctive, but common, to two districts of marble: the classical marble of Proconnesos from Marmara island and Saint-Béat marble from the French Haute-Garonne district.

Colour parameters are shown in Table 1 with values from 3 samples of Proconnesos and 12 Saint-Béat marbles. Although there is no direct relationship between the colour values of the piece and those of the marbles under comparison, it can be seen that some values are similar to those of Proconnesos: Pyrenean marbles show slightly higher Lightness function (L*) values (from 72.67 to 86.43) than those of Proconnesos (ranging from 71.82 to 76.52), while the sample under study has a value of 72.57. The white index shows a relatively low value (35.7) close to that of Proconnesos which varies from 46.2 to 56.7 while Saint-Béat ranges from 51.9 to 76.6. Comparing the reflectance spectrum of the archaeological sample (RA II) in Fig. 6, it can be seen that intensities as a function of wavelength are quite similar to those of Proconnesian marble.

The study of the thin section under the petrographic microscope confirmed the marble nature of the rock. It is a medium-coarse grained calcitic marble as it was stained red by reaction with Alizarin S. The texture is heteroblastic with bimodal development of calcite crystals: the population of larger grains varies between 1 and 2.5 mm in diameter and the smaller ones between 0.1 and 0.6 mm. Therefore, MGS is 2.5 mm. The spatial distribution of smaller crystals, together with the coarser ones, provides an almost mortar texture. But in this case, there is no great difference in size, marking a slightly porphyroblastic texture. Grain boundary shapes vary from indenting curved to interpenetrating contacts (Fig. 7).

These petrographic characteristics are common to both mentioned provenances by comparison with our own thin section database. However, in the sample under study, calcite grains have no internal strain features which are very common in French Pyrenean marbles. This feature and the noteworthy CLmicrofacies which corresponds to a weakly luminescent behaviour, typical of a low Mn^{2+} content, determine the provenance to be

1. At the ICAC (Institut Català d'Arqueologia Clàssica) Tarragona, used in the development of I+D+I HAR2008-04600/HIS Spanish Ministry Proyect.

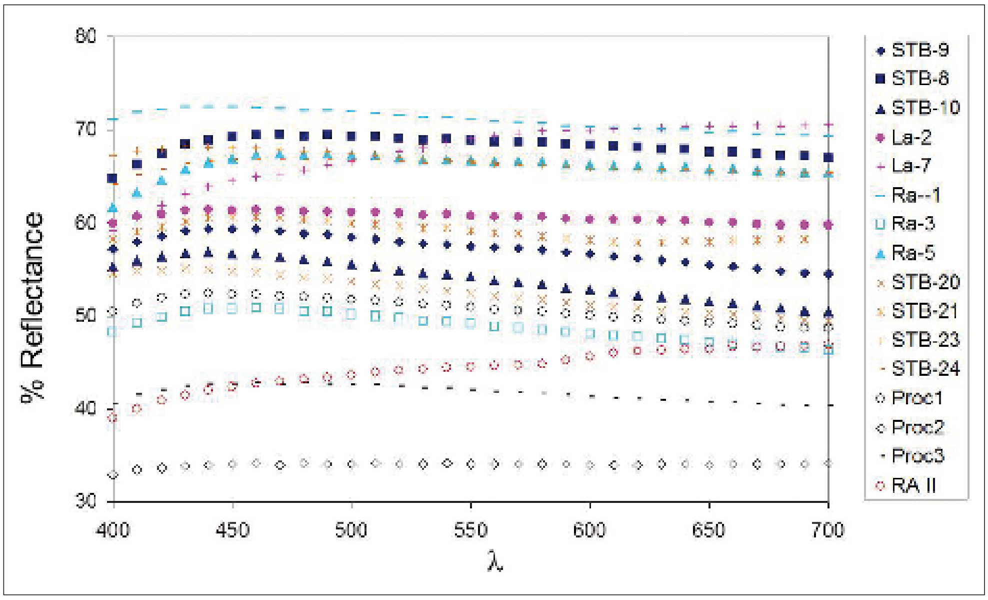

Fig. 6. Reflectance spectrum of the sarcophagus (RA II), compared to marbles of Proconnesos (Proc) and Saint-Béat (STB-, La-, Ra-).

	L*	a*	b*	WI	X	Y	Z	x	y
STB-9	80,4	-0,53	-1,61	64,5	54,3	57,5	63,4	0,31	0,3283
STB-8	86,4	-0,59	-0,2	70,1	65	68,8	74	0,31	0,3312
STB-10	78,4	-0,79	-2,5	64,4	50,9	54,1	60,6	0,31	0,3266
La-2	82,2	-0,25	-0,54	63,4	57,5	60,8	65,8	0,31	0,3302
La-7	86,4	-0,17	3,782	51,9	65,1	68,6	69	0,32	0,3384
Ra-1	87,5	-0,41	-1,07	76,6	67,2	71,1	77,6	0,31	0,3293
Ra-3	75,4	-0,83	-1,72	55,7	46,2	49,1	54,3	0,31	0,3282
Ra-5	85,4	-0,65	-0,02	67,2	63	66,8	71,5	0,31	0,3317
STB-20	77,4	-0,66	-2,37	62	49,4	52,4	58,7	0,31	0,3266
STB-21	81,3	-0,57	-1,25	64,7	55,8	59,1	64,7	0,31	0,3291
STB-23	85,3	-0,32	-1,18	72,5	63,1	66,7	73	0,31	0,329
STB-24	85,2	-0,45	-0,28	68	62,7	66,4	71,5	0,31	0,3309
Proc1	76,5	-0,65	-1,47	56,7	47,9	50,8	56	0,31	0,3285
Proc2	75,8	-0,86	-0,37	51,2	46,7	49,5	53,4	0,31	0,3311
Proc3	71,8	-0,74	-0,73	46,2	40,9	43,4	47,2	0,31	0,3302
RAII	72,6	0,48	2,65	35,7	42,6	44,7	46,2	0,32	0,3348

Table 1. Colour parameters of the sample (RA II), Saint-Béat marbles (STB-, La-, Ra-) and Proconnesos (Proc).

the quarries from Marmara island, which validate the Proconnesian origin (Fig. 8).

Proconnesos has attracted the attention of different specialists, and while its recognition by visual identification seems relatively easy, some of their macro and microscopic features are also common to other classical marbles (Attanasio *et al.* 2006, 2008). The average of MGS from 167 quarry samples of this Turkish marble offered by Attanasio *et al.* (2006), is 1.94±0.55 mm. In the extensive database by Attanasio *et al.* (2008), with 397 quarry samples, mean values of MGS range from 1.30±0.52 to 2.34±0.54, which perfectly match the marble under consideration. CLmicrofacies offered by different authors (Barbin *et al.* 1991, 1992a, 1992b; Blanc 1995) on Proconnesos marble exhibit a homogeneus very weak intensity which is shown in dark blue pattern photographs after 2 minutes of exposure in agreement with the sample under study.

To reinforce this Turkish provenance and reject the French quarries of Saint-Béat, additional techniques were applied (Quantification CL and C and O isotopes). This confirmation is especially important due to the relatively wide use of Saint-Béat marble (Lapuente *et al.* 2009) on the Spanish side of the Pyrenees (Judicial district or Conventus Caesaraugustanus) where Osca was located. Diverse works are being carried out to increase knowledge

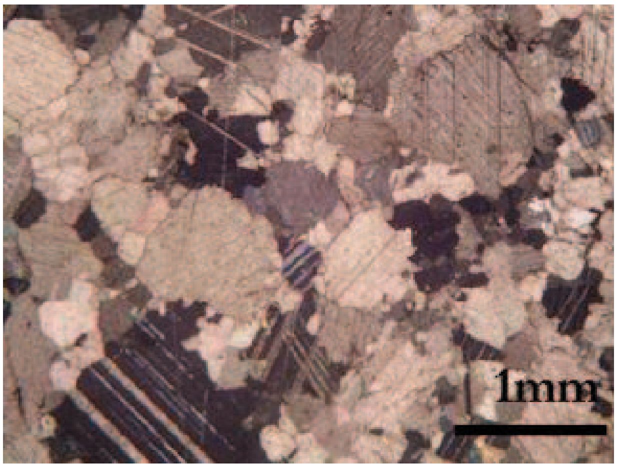

FIG. 7. Microphotograph under crossed polarizers. Typical heteroblastic texture of calcite with curved to interpenetrating contacts. Maximum grain sizes vary up to 2.5mm.

FIG. 8. Dark homogeneous cathodomicrofacies compatible with Marmara island provenance.

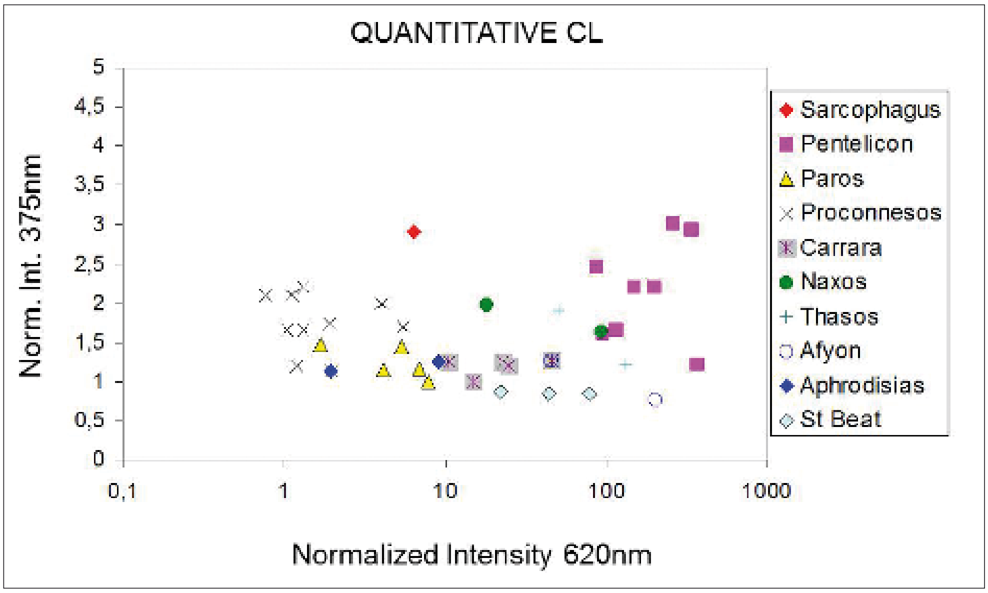

FIG. 9. Quantitative CL diagram of classical marbles including Proconnesos and Saint-Béat marbles. The intensity at 620 nm peak of the sarcophagus (6.34) is close to the values of Proconnesian marbles. However Saint-Béat. marbles exhibit higher intensities (22 to 78).

of the identification of Pyrenean quarries and also their use in Roman times.[2]

Measurements based on the intensities of the CL spectra, by means of CL+SEM equipment, were taken at 375 nm and 620 nm and plotted on a quantitative CL diagram (Fig. 9). A small representation of classical quarries is also shown in order to compare their variability on the X axis. The sarcophagus sample is plotted close to Proconnesian marbles, while Saint-Béat marbles display a higher X-axis intensity, confirming Turkish provenance.

Detailed analytical results of the isotopic distribution of Proconnesian marbles have been reported by Herz (1987), Asgari and Matthews (1995), Attanasio *et al.* (2006, 2008). Also some graphic databases (Moens *et al.* 1992; Gorgoni *et al.* 2002) are available to compare the isotopic signature of the sarcophagus. Their values of $\delta^{18}O$ (PDB) = -2.44‰ and $\delta^{13}C$ (PDB) = 1.29‰ are displayed in different isotopic diagrams (Fig. 10, 11, 12), where it can be seen that the provenance of this marble is not discriminated on the basis of isotopic analysis, although it is compatible with the two choices.

In conclusion, after all the techniques applied, Proconnesos from Marmara island is definitely the origin of this Roman sarcophagus. The combination of macroscopic, microscopic and chemical-physical properties ensures its correct identification. It is not the first time that Proconnesian marble has been identified in the Conventus Caesaraugustanus. It was recognized by archaeometric study, in several slabs from the pavement of the Caesaraugusta theatre orchestra (Lapuente 1999) and in the early Christian sarcophagus *Receptio animae* preserved in the crypt of Santa Engracia Church, Zaragoza (Lapuente *et al.* 1996).

2. These are the principal objects of the academic doctoral thesis of one of the authors (H. Royo).

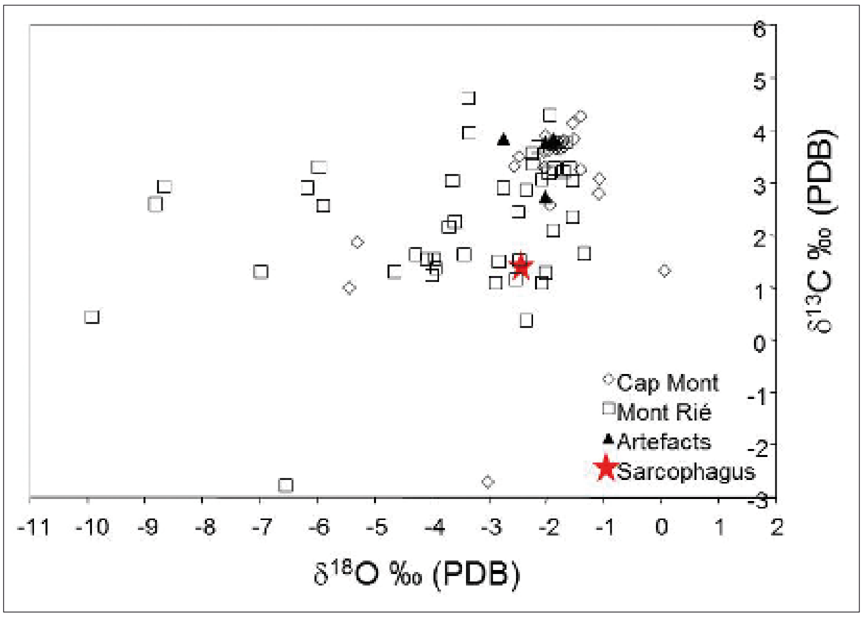

Fig. 10. Isotopic signature of the sarcophagus is compatible with values of Saint-Béat quarries (Costedoat 1995). However it is somewhat separated from the signature of other artefacts identified as Saint-Béat provenance (Lapuente *et al.* 2009).

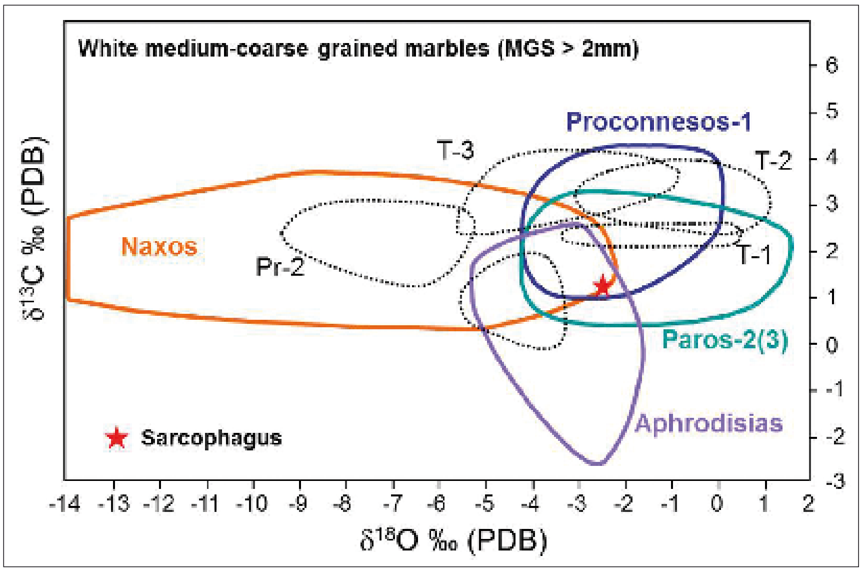

Fig. 11. Isotopic signature is compatible with Proconnesian provenance in the diagram by Gorgoni *et al.* (2002).

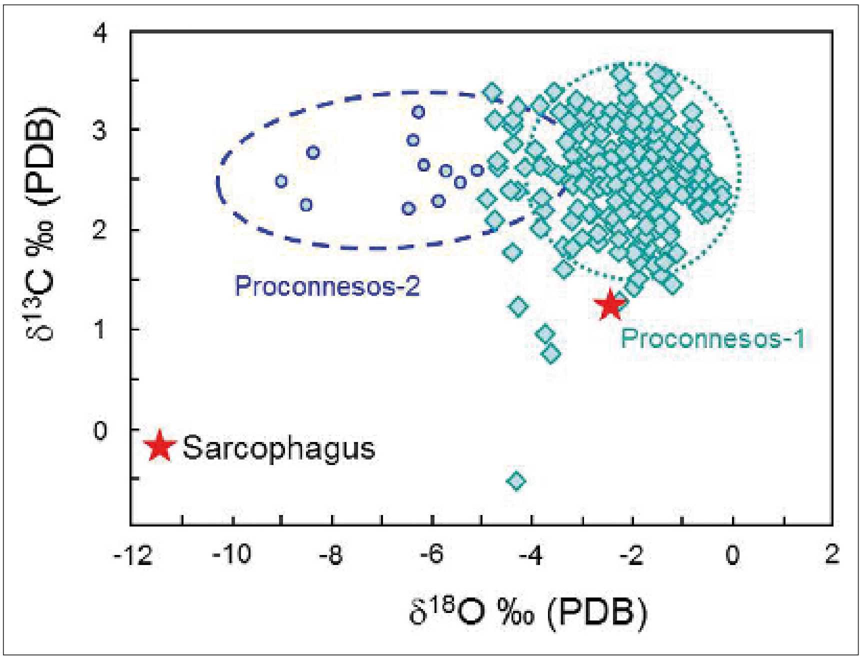

Fig. 12. In the diagram by Attanasio *et al.* (2008) the sample is accordant with Proconnesian provenance.

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