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THE SOUND OF ROCK ART. THE ACOUSTICS OF THE ROCK ART OF SOUTHERN ANDALUSIA (SPAIN)

Summary. This paper explores the potential of acoustics to interpret the prehistoric rock art of southern Andalusia (Spain). Tests undertaken in two areas, north of the Celemín river and the Bacinete area, will form the basis of our discussion. The results obtained at a selection of rock art sites show that the two key rock art sites, El Tajo de las Figuras and the large shelter at Bacinete, both with the majority of paintings in the earlier Laguna de la Janda style, had good resonance values. In contrast, at most of the other minor sites tested, the values for resonance were negative or insignificant, regardless of whether they were painted in Laguna de la Janda or schematic style. We conclude that the major rock art sites in southern Andalusia were chosen not only for their geological appearance and location in the landscape, but also for their acoustic properties.

INTRODUCTION

Research into the use of sound by past societies is gathering momentum worldwide. Although it began more than a century ago with studies of musical instruments (Piette 1874), its remit has widened to include the acoustic properties of the place in which vocal or instrumental music may have been produced. Since the 1990s the field has seen a new generation of researchers producing literature in the US (Waller 2000), South Africa (Ouzman 2001) and the UK (Scarre and Lawson 2006), where special emphasis has been placed on megalithic structures in recent years (Till 2010; Watson 2006). More recently, research on acoustics has expanded to include Africa (Kleinitz 2004; Mazel 2011), America (Garfinkel and Waller 2012), Asia (Boivin *et al.* 2007) and other areas of Europe (García Benito and Jiménez 2012; Jiménez 2009; Lahelma 2010; Mills 2010). New finds show that instruments have been produced for at least the last 40,000 years (Conard *et al.* 2009).

Archaeoacoustics is a field of research in its infancy in Spain. Despite some early work (Pericot 1936; 1943), little was published until the 1990s. An exception to this, as far as prehistoric art is concerned, were the publications in the 1980s by the Belgian archaeologist Lya Dams on the lithophones of the Cave of Nerja (Malaga province) (Dams 1984; 1985). In her study she explored the potential of earlier suggestions by the French pioneer, the Abbé André Glory, who noted the musical effect obtained from the calcite folds in the formation known as the

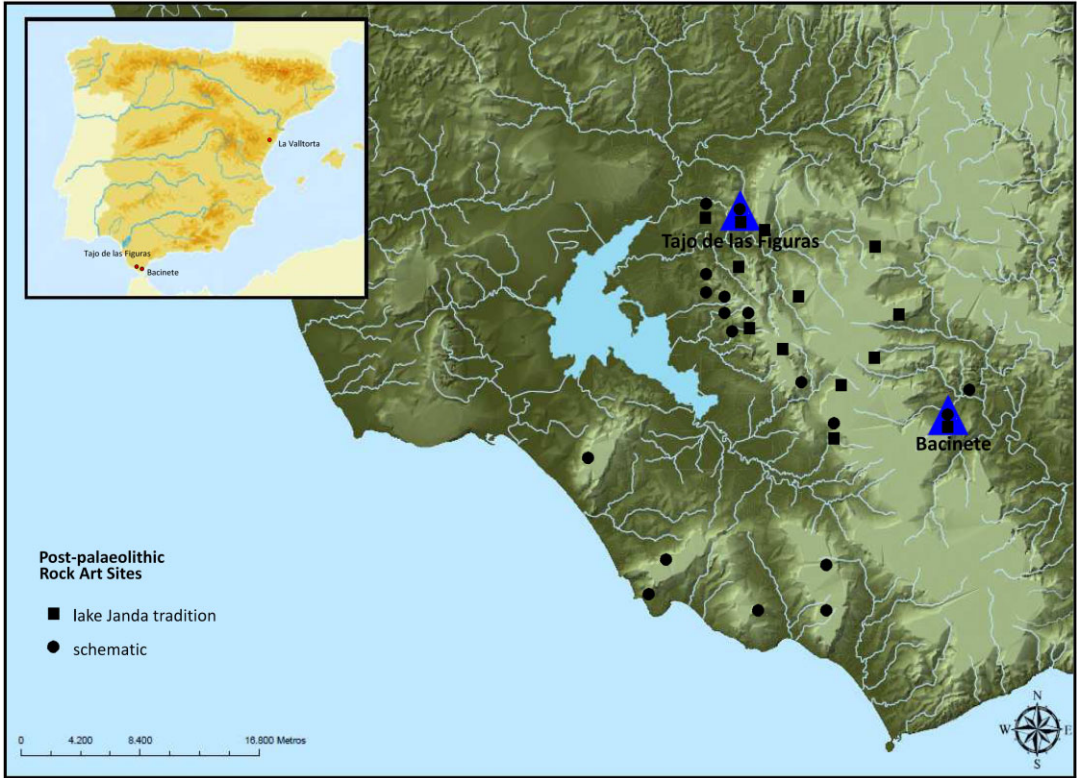


Figure 1

Map of southern Andalusia showing post-Palaeolithic rock art sites. The sites of El Tajo de las Figuras and Bacinete are marked with a triangle.

Organ (Glory *et al.* 1965). It is in the past 15 years that we have seen a renaissance of interest in music and acoustics. Studies have been carried out on the production of music with instruments from the Upper Palaeolithic to the Neolithic (Baena *et al.* 1998; García Benito 2012; García Benito and Jiménez 2011; 2012; Hortelano 2008; Jiménez 2009; Martí *et al.* 2001; Menéndez and García 1998; Soler and García 1994). These have been complemented by further research dealing with later periods (Mederos Martín 1996; Moreno-García 2005). In terms of rock art studies, some open-air rock art motifs have been interpreted as musical instruments, including cymbals (Beltrán 1988), flutes (Baldellou *et al.* 2000), possible banging sticks (*palillos*) (Alonso and Grimal 1995, 14–15) and clapping hands (Utrilla and Martínez Bea 2005, 170, fig. 6). Dancing has also been mentioned at a few sites (*ibid.*; Beltrán 1969). In the last two years interest in acoustics has included the sonority of sites. In this regard, the research undertaken by two of the members of this team at La Valltorta Gorge was the first project to study the acoustics of rock art sites in terms of their importance and location in the landscape (Díaz-Andreu and García Benito 2012).

La Valltorta Gorge is in eastern Spain (Fig. 1) and the majority of its paintings are Levantine in style. The tests undertaken in July 2011 have made it possible to argue that the

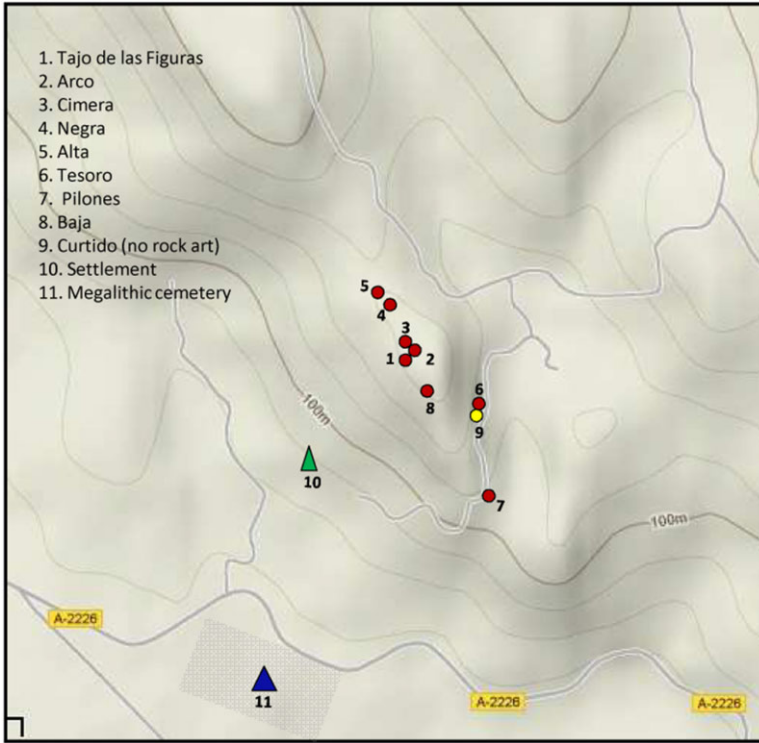


Figure 2
Map with sites north of the Celemin river.

contrast between the areas of the gorge with and without rock art sites clearly shows that the shelters to be decorated were chosen in the sector with the best acoustic properties. The analysis also showed that the three places with the most motifs had the best acoustics, especially when the tests were carried out on the gully bed, and that the values for echoes were also better in the case of the three major sites. In contrast, minor rock art sites gave better results when resonance was tested facing the rock art panels at the back of the shelter. The results showed that the rock art sites of Valltorta had been selected because sound was an important component in their use, especially those with the largest number of motifs, which may be considered as having the greatest ritual significance (Díaz-Andreu and García Benito 2012).

In this article our aim is to contribute further to research into the relationship between acoustics and rock art. As in the case of Valltorta, the art produced in the tested rock art shelters was painted in the open air and is post-Palaeolithic. This analysis will explore the extent to which acoustics may have been a factor in the selection of rock art sites in southern Andalusia and will compare the results with those obtained in the Levantine rock art area of Valltorta (eastern Spain).

TESTING THE ACOUSTICS OF POST-PALAEOLITHIC ROCK ART SITES IN SOUTHERN ANDALUSIA

Two hundred and fifty-five rock art shelters have been identified in the province of Cádiz in southern Andalusia. Many of them are located in the mountain ranges running parallel to and



Figure 3
El Tajo de las Figuras. View of entrance. Photo: María Lazarich.

about 20 km from the Atlantic coast, as well as in some of the hills nearer the sea (Figs. 1 and 2). In this area a small number of sites contain rock art dated to the Palaeolithic, although the great majority have a post-Palaeolithic chronology and these are the only ones analysed in this article. Surveys undertaken in the area show that the sites to be decorated were obviously selected, as many rock shelters were left devoid of any painted images (Carreras 2011, 95; Lazarich *et al.* 2012, 184). Even though the general trend was to decorate shelters with wide visibility, those that did not receive direct sunlight were not normally chosen (Carreras 2011, 95).

There are two main styles in the post-Palaeolithic paintings of southern Andalusia. The first is a singular, distinctive style, identified here as the Laguna de la Janda rock art tradition. Motifs in this style are highly detailed, to the extent that in zoomorphs, for example, it is often possible to identify the species. Those identified include some that are not common anywhere else on the Iberian Peninsula, such as birds found only at four sites (raven, ducks, cranes, wild geese and many other marsh birds). It should be borne in mind that the area is not far from marshland. It is close to the Doñana National Park, although the current extent of this nature reserve is partly due to modern water management. More importantly, many of the sites were close to the now dry Lake Janda (Laguna de la Janda in Spanish). This natural lagoon was drained half a century ago to create land for pasture and cultivation (Recio 2007). Lake Janda was large, fairly shallow and a key resource for the communities living nearby. Many migratory birds stopped there on their way between Africa and Europe. In addition to birds, there are many



Figure 4
El Tajo de las Figuras. Detail of panel. Photo: María Lazarich.

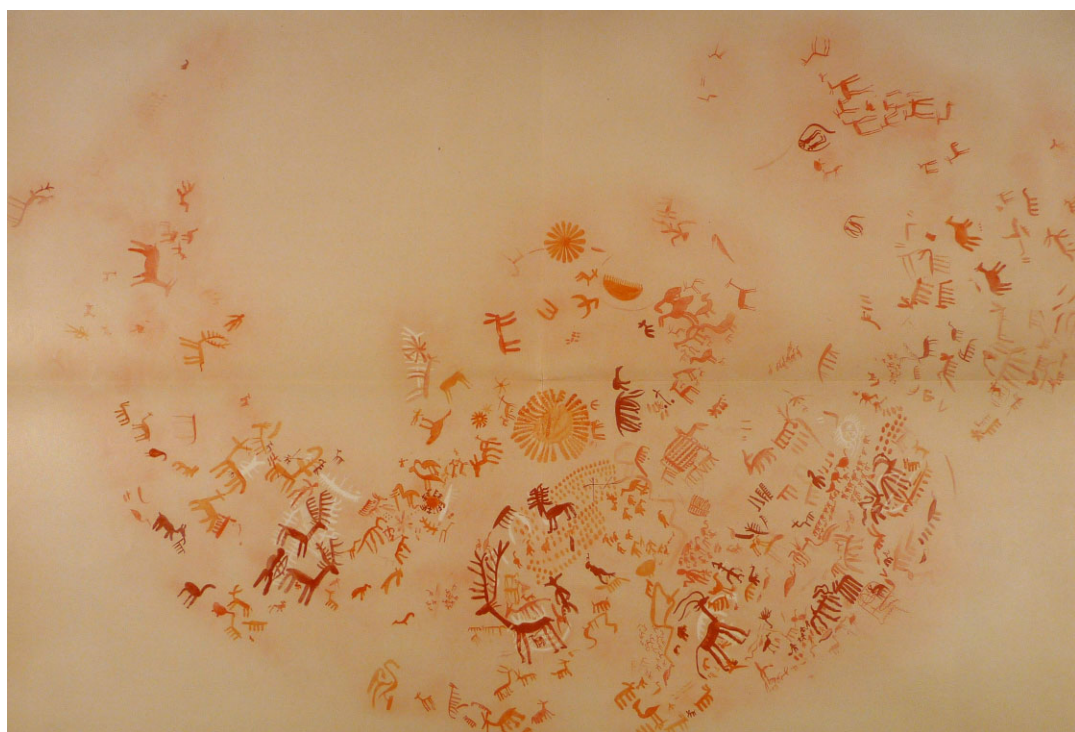


Figure 5
Interpretation of the El Tajo de las Figuras panel by Breuil (Breuil and Burkitt 1929, plate in pocket at end).

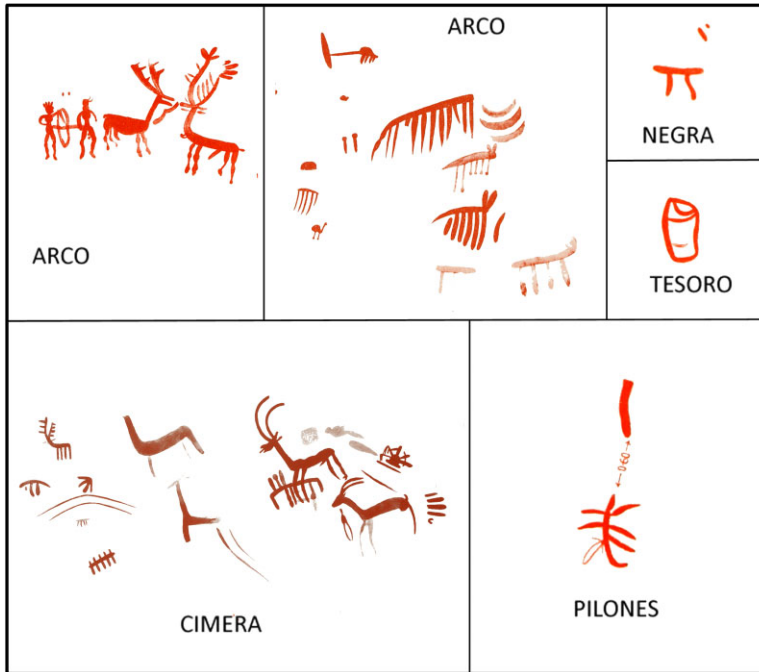


Figure 6
Rock art motifs at Arco, Negra, Cimera, Pilonos and Tesoro (Breuil and Burkitt 1929, pls. V–VIII).

other depictions representing zoomorphs such as deer, including many stags, and horses. Zoomorphs are the most common motif (77.8 per cent), followed by anthropomorphs (12 per cent). In the latter, the depiction of gender was not considered important (or perhaps it was thought to be evident, with no need for further detail). Tools may have been important in some way, as several anthropomorphs are associated with objects such as tools, headdresses and weapons. There are compositions of motifs that are clustered together or form lines. Sizes vary from large, 70 cm high motifs to those that are tiny at 2 cm high. The most common colour is red, obtained from iron oxides (Lazarich *et al.* 2012). In addition to the Laguna de la Janda style, schematic art similar to that found across most of the Iberian Peninsula is also present. There is a contrast between the coastal mountains, where only the schematic style is found, and the interior mountains, where both are present, sometimes in the same shelter (Carreras 2011, 100; Lazarich *et al.* 2012, 188). The existence of superimpositions indicates that schematic paintings came later (Breuil and Burkitt 1929, 83–4; Cabré and Hernández Pacheco 1914, 26), although it is likely that both styles share a Neolithic chronology, with the schematic style continuing into later periods.

In August 2012 a set of acoustics tests was carried out at rock art sites in southern Andalusia. Two sets of sites were tested. The first was located to the north of the old course of the Celemín river, now part of a reservoir, where six shelters (known locally as *cuevas* or caves) were selected. These were the rock art sites of El Tajo de las Figuras, Arco, Cimera, Negra, Tesoro and another, Curtido, where fake paintings were made a few years ago. The second set of tests was undertaken in an area more than 22 km away, in the rock art group of Bacinete in the



Figure 7

Testing acoustics at the entrance of El Tajo de las Figuras rock art site. Margarita Díaz-Andreu and Carlos García Benito. Photo: Gao Qian.

Palmones river valley. As research to date has identified both El Tajo de las Figuras and the large shelter at Bacinete as key sites, more than one set of tests was carried out in each of them. At these two sites most of the motifs can be classified within the Laguna de la Janda rock art style, whereas most sites nearby are painted in the schematic style.

The acoustics of the rock art sites north of the Celemín river

A series of shelters was decorated with rock art in the Sierra de la Momia mountains to the north of the Celemín river. The best known among them is El Tajo de las Figuras, which is widely considered by all scholars to be the most emblematic site of the whole area (Figs. 3–5). El Tajo de las Figuras has a long history of research, having first come to scholarly attention in 1913 (Breuil and Burkitt 1929, ch. II; Cabré and Hernández Pacheco 1914; Hernández Pacheco and Cabré 1913; Mas 2005). Its location, visibility in the landscape and the number of painted motifs make it an exceptional rock art site. It is a deep shelter (8 m), with a round-shaped entrance and a slippery sloping floor (almost 45°). It is visible from afar and, correspondingly, from its entrance there is a wide panoramic view of the area once occupied by Lake Janda, of the mountains that border it to the south and of the megalithic cemetery (Breuil and Verner 1917; Lazarich *et al.* 2012, 192–4), which is no more than 600 m away.

In addition to El Tajo de las Figuras, tests were undertaken at five more shelters on the same hill: Arco, Cimera (also known as Cochinos), Negra, Tesoro (called Cueva de la Paja by

TABLE 1
Tests undertaken at the Laguna de la Janda and Bacinete rock art areas

Reverberation (facing the back wall of the shelter)	Laguna de la Janda rock art sites							Large Shelter at Bacinete* ²			
	Tajo de las Figuras* ¹			Cueva del Arco	Cueva Cimera	Cueva Negra	Cueva del Tesoro	Cueva del Curtido	T1	T2a	T3
	T1	T2	T3								
Clapping	0	0	0	0	0* ³	1	0	1	0	0	0
Two whistles	1	1	0	0	0	0	0	1	1	1	1
One intermittent whistle	2	1	0	0	1	0	1	2	1	2	2
Voices	1	1	0	0	0	0	0	0	1	1	1
Male voice	0	1	0	0	0	0	0	0	1	1	0
Female voice	0	0	0	0	0	0	0	0	0	1	1

Reverberation (facing outwards)	Laguna de la Janda rock art sites							Large Shelter at Bacinete* ²			
	Tajo de las Figuras* ¹			Arco	Cimera	Negra	Tesoro	Curtido	T1	T2b	T3* ⁴
	T1	T2	T3								
Clapping	0* ³	0	0	0	0* ³	0	0	1	0	0	–
Two whistles	1* ³	1	1	0	0	0	0	1	1	1	–
One intermittent whistle	1* ³	1	0	0	1	0	1	1	1	1	–
Voices	1	0	1	0	0	0	0	0	1	0	–
Male voice	0	0	0	0	0	0	0	0	2	1	–
Female voice	0	0	0	0	0	0	0	0	0	1	–

Reverberation values: 0: no reverberation; 1: short and soft reverberation (1 s. or less); 2: long and hard reverberation (more than 1 s.).

*¹ See Figure 8a for the location of the emitter and the receiver. *² See Figure 8b. *³ The receiver gets saturated when receiving the sound. *⁴ There was no test facing outward because both the emitter and the receiver were out of the shelter.

Breuil) (Fig. 6) and Curtido, the last of these having only fake rock art. The Arco cave may have had a very different appearance in the past, as the arch that has to be crossed today to enter the decorated area may have been the entrance to a deep shelter where the decorations were made. Today the fallen ceiling lies on the floor of the space in front of what remains of the shelter. In it some deer were painted in the Laguna de la Janda style, together with a human couple holding what could be an arch. Cimera is located close to the summit of the hill. It has at least two goats and some other symbols. Cueva Negra has only some indeterminate motifs and Cueva del Tesoro has a single motif that Acosta identified as a phallus (Acosta 1968, 161, fig. 54.7). As previously explained, in Curtido the only paintings are modern, although they are copies of known Palaeolithic and Levantine art motifs, together with others that are more imaginative.

Thirty-two acoustic test series were carried out at the rock art sites north of the Celemín to see whether there was a difference between the results we were finding in the caves decorated in prehistory and in others left unpainted. Following the method used in La Valltorta Gorge, each test series included six types of sound: clapping for approximately 5 seconds, two whistles of different musical notes (C₇/C#₇ and G₇/G#₇, obtaining a fifth interval), an intermittent whistle on its own (G₇/G#₇), two male and female voices together and then each of them separately, always using the sound ‘a’ (see Table 1). At each site we did two series of tests, first facing the rock art panel and then facing outwards, testing both resonance and echoes. Owing to its special nature,

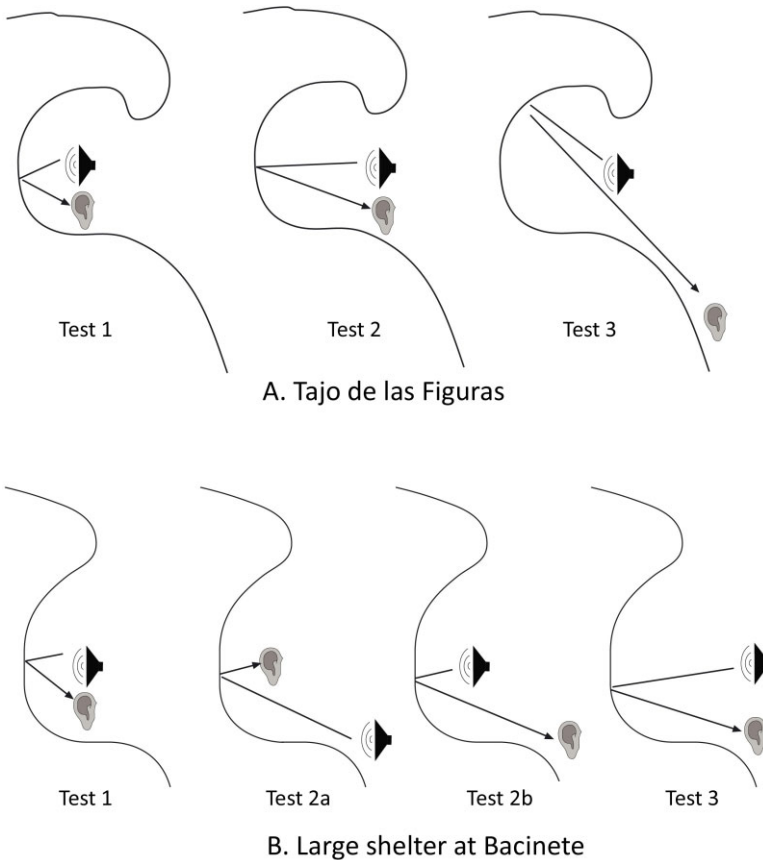


Figure 8

Diagram showing emitter and receiver location for the tests at El Tajo de las Figuras and the large shelter at Bacinete. Figure by Antonio Ramos.

we paid particular attention to the El Tajo de las Figuras rock art site and carried out three test series instead of one (Figs. 7 and 8). In the first test both the emitter and the receiver were placed in the area of the cave furthest from the entrance. In the second they were at the entrance, and in the third the emitter was at the entrance and the receiver at the bottom of the cliff. We tested for reverberation and for echoes, but the results of the latter were almost unanimously negative, with the exception of a few instances in the large shelter of Bacinete.

Bacinete

Bacinete is not a single shelter, but a series of rock formations with several shelters, some of them containing paintings (Fig. 9). They are in an area with a higher humidity than the surrounding landscape, close to the confluence of two rivers, the Ojén and the Palmones. From the shelter located more to the south-east there is a wide view of the surrounding landscape, including Algeciras Bay and the Rock of Gibraltar. There are nine shelters with paintings. The

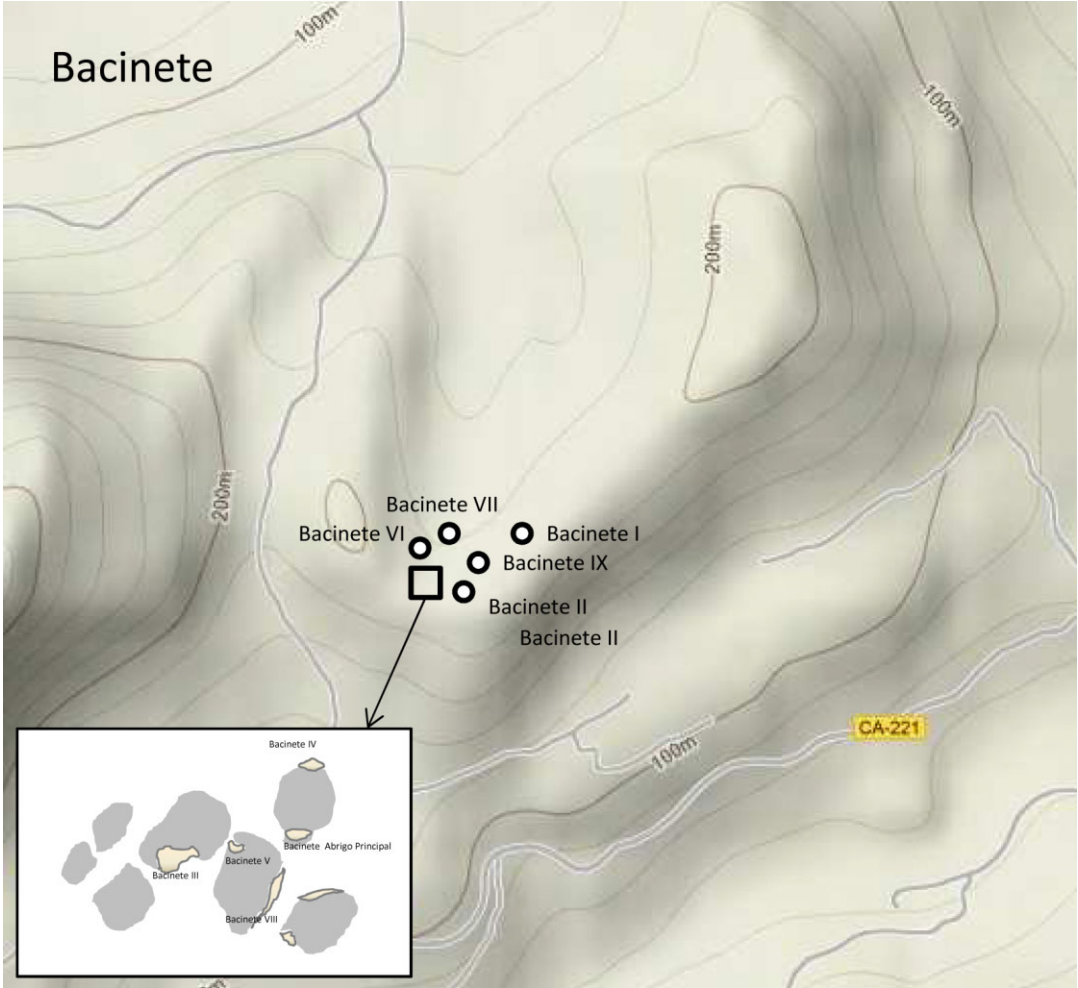


Figure 9
Sketch of rock art sites at Bacinete.

one with the largest number of motifs is known as the large shelter at Bacinete or the main shelter (*abrigo principal*). It has a space in front of it which would have allowed a large group of people to watch what was happening at the site. The space is surrounded by rocks, some with other shelters that are also decorated. The large shelter at Bacinete was first published by Breuil and Burkitt (1929, pl. XXVII) on the basis of the notes taken by Breuil and Willoughby Verner in 1919 (Ripoll Perelló 1994; Solís 2003–4). Bacinete has a large number of zoomorphs, mainly deer and goats. There are also anthropomorphs interpreted as men, some with tools. Interestingly, in the middle of two sets of figures there is an anthropomorph with one or two hands open showing the fingers. Not far from the large shelter there is a small cave with a few schematic motifs (Figs. 10 and 11). Other painted shelters in the Bacinete group display series of lines formed by circles, while others have more classical schematic motifs (Fig. 12).



Figure 10
The large shelter at Bacinete. Photo: María Lazarich.

Tests were carried out in the large shelter, the only one which seemed to have any possibility of possessing good acoustics. Several test series were undertaken: the first with the emitter and the receiver in the shelter itself, the second with the emitter inside the rock shelter and the receiver in the auditorium area in front of it (when the test was made facing outward the emitter and the receiver changed positions), and the third with both the emitter and the receiver in the auditorium area (Figs. 8 and 13; Table 1).

DISCUSSION

Recent attention paid to the sensorial properties of rock art sites has made it clear that many rock art traditions around the world took into account their acoustic values. In this article the results of the acoustics tests undertaken at a selection of rock art sites in southern Andalusia in August 2012 have been discussed. Although these are not as spectacular as those obtained at Valltorta (Díaz-Andreu and García Benito 2012), at least the two key rock art sites showed certain acoustic properties. These are El Tajo de las Figuras and the large shelter at Bacinete. Both have a larger number of motifs depicted in them and their location in the landscape denotes them as special places. In addition, at both of them most of the motifs are in the Laguna de la Janda style, whereas some of the minor sites around them may exclusively display schematic art. Resonance was present in the El Tajo de las Figuras shelter and in the large shelter at Bacinete (Table 1). These figures were replicated when the tests checked the resonance facing outwards from the main panel, with El Tajo de las Figuras giving the best results and Bacinete also providing very good results. Of all the sounds, whistles perhaps gave the best values, followed by the male voice. Echoes, however, were not found at El Tajo de las Figuras and were less than spectacular in the large shelter at Bacinete.

In contrast to the key sites of El Tajo de las Figuras and the large shelter at Bacinete, at most of the other sites tested the values for both resonance and echoes were negative. This shows



Figure 11
 Rock art motifs in the large shelter at Bacinete (Breuil and Burkitt 1929, pl. XXVII). Bottom half, left side of panel.

a clear difference with the results obtained at the minor sites of the Valltorta Gorge, where all the rock art sites provided positive values for resonance. At Valltorta there was also a clear difference between the area of the gorge without decorated rock shelters and the sections with paintings. However, this type of test was impossible to replicate in the Laguna de la Janda and Bacinete areas, given that the paintings are not located in a gorge. Surprisingly, most minor sites in southern Andalusia gave negative values, even in the tests undertaken looking towards the rock art panel, where resonance is expected to be good. Exceptions to the rule were Cueva del Tesoro and Cueva del Curtido, the latter with no prehistoric paintings. Good acoustic properties, therefore, were not sought-after when minor rock shelters were selected for painting a few figures, whether they were in the Laguna de la Janda or the schematic style. We would like to argue that acoustic resonance was one of the factors taken into account in the selection of major sites: in our case study El Tajo de las Figuras and the large shelter at Bacinete, both with the majority of paintings in the Laguna de la Janda rock art style. At the time when the schematic style replaced that of the Laguna de la Janda, people already had an inscribed landscape that they

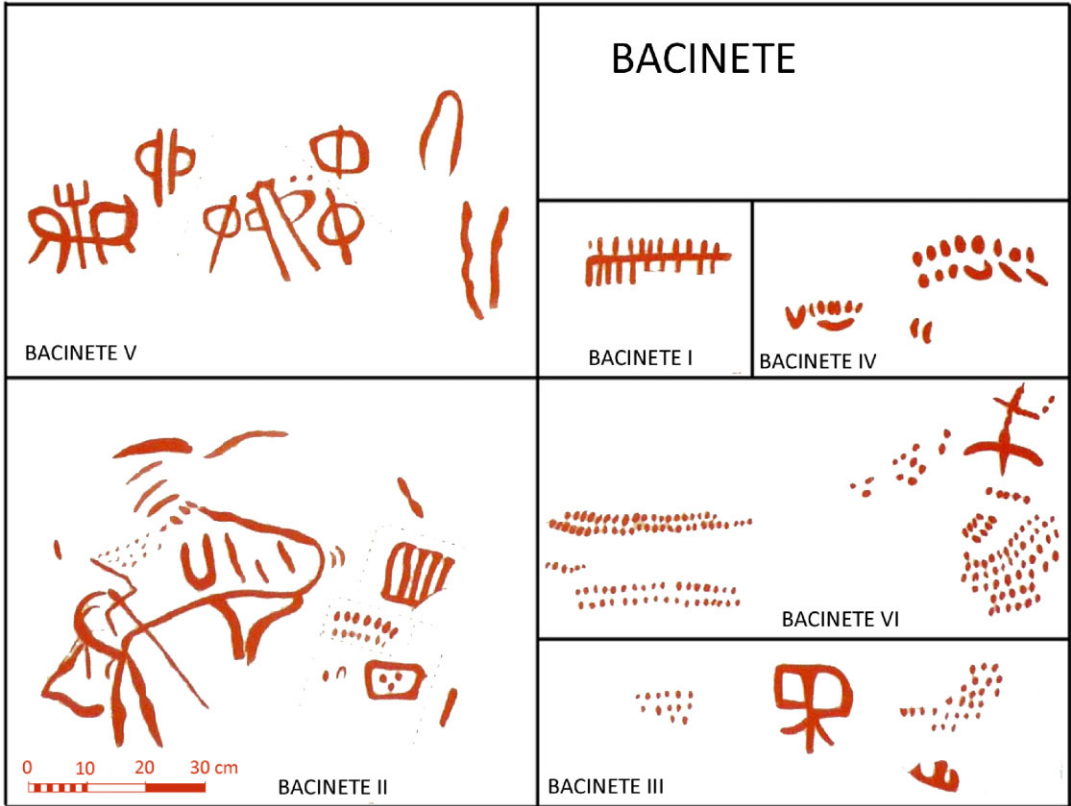


Figure 12

Rock art motifs in other shelters at Bacinete (based on Breuil and Burkitt 1929, pl. XXVI).

used and to which they added their own new sites. However, in the latter acoustic properties were not sought.

In what ways was sound used at El Tajo de las Figuras and in the large shelter at Bacinete? The information regarding what kinds of sound were made there has been lost forever. Music is a type of cultural activity that does not necessarily leave physical remains. This is especially true in the case of vocal music, which leaves no trace whatsoever. Many of the instruments that may have been used in prehistory were made of perishable materials which may not have been preserved. Scholars have been able to document a range of musical instruments – bullroarers, rasps, pipes and flutes, phalangeal whistles, other bone instruments, percussive instruments and lithophones – from at least the Upper Palaeolithic (Morley 2003; 2005). It is assumed their use continued until the Late Bronze Age, when a new set of instruments, including bells and lyres, appears in the archaeological record. In contrast to Valltorta, where in a 300 km radius around the site there have been several finds of flutes dated to the Neolithic and also to earlier periods (Martí *et al.* 2001, 61–2, fig. 10), in southern Andalusia there are few known examples of prehistoric instruments, although this may be due to a lack of awareness among



Figure 13

Testing acoustics at the large shelter at Bacinete. Students Gao Qian and Francisco Torres help with the testing.
Photo: Margarita Díaz-Andreu.

specialists. Only a rattle, a possible whistle fragment and two conch shell aerophones are known. The rattle is in the shape of a ship. It was recovered from the Cerro de la Cabeza sector of the Valencina de la Concepción archaeological site in 1975 (Fernando Fernández and Juan Manuel Vargas, pers. comm. 8 November 2012), and is now on display at the Archaeological Museum of Seville with the Inventory Number SN8A-27. Although the rattle was found out of context, it has been dated to the Neolithic. The other two known instruments have been dated to the Chalcolithic. A possible whistle fragment was found in one of the artificial burial caves of Alcaide by Bernardo Berdichewsky (1964, 121, fig. 49-7). In the 1970s the excavations were continued by Ignacio Marqués and J. Ferrerand; although they included the perforated bone in their publication, they explained that they had been unable to find it among the other material stored in the museum from the earlier excavations (Marqués and Ferrer 1976, 77, fig. 5 no. 6). Finally, during the excavation of a Punic site in Amílcar Barca Avenue in Cádiz a few objects found in a pit were dated to the Chalcolithic. They included two conch shell aerophones (Niveau 2006, 12, pl. IX; 2009, 12–13; Sibón 2001).

In hunter-gatherer and early agriculturalist societies, the types that produced both the Levantine rock art of the Valltorta Gorge and the Laguna de la Janda rock art tradition, the use of music as a form of communication has been seen by anthropologists as a key component of ritual. This is the case, for example, of ancestor worship as one of the elements necessary to prepare ritual objects (Zhao 2006) and in other cases as a way to ‘resituate centres of social power present in indigenous mytho-historical accounts’ (Prufer 2006, 574). In some societies, sound can be as significant as vision (Gell 1995) and in others it is linked to particular ritual activities, such as the production of the sedative drink sakau (kava) (Rainbird 2002a; 2002b). It is known that in some rock art traditions for which we have informed sources, spells, chants and songs were sung in association with the selection of the location to be decorated, as well as in the production of the art itself (Smith 1993; Whitley 2001). Although we cannot rule out

that some of the rock art sites were used for more mundane purposes, the symbolic component of the paintings seems to point to a high probability of ritual use. The importance of acoustics at the sites with the largest number of paintings seems to indicate that sound was a component of ritual performance in them. The high resonance in these locations may have had an influence on the neurological and physiological stimuli experienced in them. In summary, we would like to propose that on the basis of the results obtained in our tests, both in the Valltorta Gorge and in southern Andalusia, at the places where people painted in the Laguna de la Janda style, we are not only dealing with landscapes ritually marked with paintings, as scholarship has so far proposed, but also with soundscapes. This is a dimension that future enquiries into rock art should certainly integrate as a necessary component of research.

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