Research Article

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Music and Storytelling at Rock Art Sites? The Archaeoacoustics of the Urkosh Area (Russian Altai)

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Abstract: In this article, the potential of archaeoacoustics for understanding past communities is discussed by looking at a range of acoustic parameters. Our case study is the Urkosh rock art area in the Ongudai district, Republic of Altai (Russia). The rock art of this area dates possibly from the Upper Palaeolithic and definitely from the Early Bronze Age (second half of the third millennium BCE). There are important periods in the Early Iron Age (first half of the first millennium BCE) and the medieval era, after which there are later additions up to the present day. Major and minor sites were tested, as well as some with no art. The results obtained from the tests conducted using the impulse response method indicate high values for sound clarity not only in the rock art sites but also in at least one nearby panel without rock art. Although these results cannot explain why rock art was produced precisely in specific locations, they objectively describe the acoustic conditions under which particular intangible cultural practices were probably organised in them. In particular we focus on storytelling and music, cultural practices for which there is a wealth of information in the ethnographic sources written about the area.

Keywords: archaeoacoustics, acoustic measurements, impulse response method, intangible heritage, soundscape

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1 Introduction

Archaeoacoustics is a growing sub-field of archaeology that aims to explore the cultural understanding of sound and music in past communities. The term was coined in the 2000s (Scarre & Lawson, 2006) and encompasses a series of studies that have been taking place for a long time. For example, studies of musical instruments began in the eighteenth century (Basire, 1789; Cooper Walker, 1786; Thomsen, 1836), and the term Music Archaeology was used for the first time as early as 1848 by the musician Daussoigne-Mehul (see also Arbaud, 1857). In addition to musical instruments, since the mid-twentieth century, some scholars have also taken an interest in the acoustical study of partially open buildings such as *odea* and theatres (Canac, 1967) (for more modern literature, see Astolfi, Bo, Aletta, & Shtrepi, 2020; Gupta, 2021; Tronchin, Merli, Bevilacqua, Dolci, & Berardi, 2021). The acoustics of other open spaces is also attracting increasing attention. There are, for example, studies of the effectiveness of particular places for speech intelligibility (Boren, 2019; Ferrari, Leibowicz, & Acuto, 2017; Holter, Muth, & Schwesinger, 2018; Izaguirre & Ferrari, 2018; Kopij & Pilch, 2019). However, the term archaeoacoustics was not created in vain, as it has proved extremely effective for merging all these different strands into a single research field that is attracting increasing interest.

For several decades, rock art researchers have been aware of the possible relationship between rock art and sound (for the earliest see Glory, 1964). Scholars have analysed the connection between carved and painted images and music. They have followed several alternative lines of enquiry, including looking at the representations of musical instruments on panels and identifying actual musical instruments found at rock art sites. Some have also examined the possible use of the rock on which the art was produced in boulders, shelters, or caves as a musical instrument (see Díaz-Andreu & Mattioli, 2019, pp. 505–514). Others have considered the special acoustic character of certain landscapes as a possible factor behind the decision to produce rock art in particular areas (Coles, 1991, p. 133; Devereux, 2008, pp. 27–28; Goldhahn, 2002; Mazel, 2011). The relationship between image and sound has also been explored by investigating the location of rock art in landscapes where artificially produced sounds, including human musical activity, are able to generate exceptional acoustic responses (for some earlier studies see Conway, 1993, pp. 149–157; Reznikoff, 1995; Steinbring, 1992; Waller, 2000). Some of the authors of this text have been working on this line of research for a decade, assessing the relationship between rock art and sound. Our earliest studies focused on reverberation and echoes (Díaz-Andreu & García Benito, 2012, 2015; Mattioli & Díaz-Andreu, 2017). Considering that more sophisticated acoustic parameters and rigorous methodologies were needed, we borrowed methods from acoustical physics. Working together with the renowned acoustic engineer, Prof. Angelo Farina, we were able to accurately measure *in situ* the acoustical properties of sites (Farina & Ugolotti, 1999) and expand the number of acoustic parameters to be measured (Alvarez-Morales et al., 2023; Díaz-Andreu et al., 2021; Santos da Rosa, Alvarez-Morales, Martorell Briz, Fernández Macías, & Díaz-Andreu García, 2023). We have also explored sound perception of and from rock art sites using a set of GIS tools (García Atiénzar, Barciela González, Santos da Rosa, & Díaz-Andreu, 2022). This article follows our line of research looking at the relationship between rock art and sound.

In this article, we aim to explore the potential of observing the acoustics of the place to understand the location of rock art. In part, this was the objective of a previous study related to the rock art of the Lower Chuya Valley in the Republic of Altai (Díaz-Andreu et al., 2022, 2023). The case to be analysed here is the area of Urkosh, some kilometres to the north of our previous case study and already superficially touched upon in a shorter article (Díaz-Andreu et al., 2022). In this article, our focus will be on storytelling and music, key cultural practices in Siberia. With our work, we would like to highlight the misunderstanding deriving from the definition of archaeology as “the study of the ancient and recent human past through *material remains*” (SAA, n.d., our emphasis). This description disregards the importance of the intangible aspects of culture, such as storytelling and music. As anthropology reminds us, both are fundamental manifestations of social behaviour, and common practice in every society (Morley, 2014; Smith et al., 2017; Stevens & Byron, 2016). We would like to argue that archaeologists need ways of approaching both of these cultural practices and that archaeoacoustics may provide the tools to do this.

2 The Study Area

The area of Urkosh (Russian: Уркош), where the acoustic tests discussed in this article were conducted in August 2019, is situated in the Altai Mountains. The mountain range covers a large region elongated towards its northwest-southeastern axis that covers some 845,000 km^2, an area approximately equivalent to France and Germany together. The mountain range represents the meeting place between Siberia and Central Asia and is the transitional zone between the Mongolian, South Siberian, and Kazakh steppes. Administratively, it is divided between four different countries: Russia, Mongolia, China, and Kazakhstan (Figure 1a). In Russia, the Altai Mountains are found in the southern half of the Altai Republic and the far western part of Tuva. The first is crossed from north to south/southeast by a highway, the Chuysky (Chuiskii) Tract. This is an ancient route that probably dates from the time of the Silk Road and perhaps even earlier (Tishkin & Seregin, 2010, p. 133). A wealth of archaeological remains has been identified all along the Chuysky Tract. Rock art sites are one of the more abundant sites. In this context, four different rock art concentrations were subject to our investigation in August 2019: two areas that will be the focus of future studies, Kuyus and the Karakol Valleys, the lower Chuya Valley has already been published (Díaz-Andreu et al. 2022, 2023) and, finally, the Urkosh area, the focus of this study.

The Urkosh area is located next to the Katun River, the longest watercourse in Russian Altai, stretching for almost 700 km before it flows into the Biya to become the Ob River. The Katun originates on the southwestern slope of Belukha (Белуха) Mountain, which is not only the highest mountain of Altai, but also a sacred place to all Altaians. The Katun River is a central element in the culture of the indigenous Altaians (Klubnikin, Annett, Cherkasova, Shishin, & Fotieva, 2000). The section of the river in which the fieldwork was carried out is close to the confluence with the Big Yaloman (Ialoman) tributary, approximately 5 km north of the rural village of Malyi Yaloman (Малый Яломан, meaning Small Yaloman) in Ongudai District (Figure 1b). On this stretch, the Katun looks like a huge free-flowing watercourse that alternates between narrow, recessed gorges and broad flood plains up to 2 km wide. The river has a considerable discharge rate in this area. Both sides of the valley are characterised by high fluvial terraces (up to 150 m from the riverbed) with flat summits and steep slopes covered by grassland fields (Figure 2). These fluvial terraces are massive sedimentary bodies caused by Late Pleistocene cataclysmic floods of the Katun river and the erosional processes of the main watercourse and its tributaries during subsequent eras (Carling, Kirkbride, Parnachov, Borodavko, & Berger, 2002). The mountain range to the west is characterised by rugged, barren reliefs with frequent rockslides, screes, and rock walls mainly composed of granitoids and granodiorites (Safonova, 2014, Figure 8).

Archaeological research in the Urkosh area began at the end of the 1980s with the discovery on the west bank of the river of the Bronze Age depictions of the so-called "dancing" archers of Yaloman III (Яломан III) or Grand Yaloman, first published by Surazakov (1996, p. 82; Tishkin & Seregin, 2010, p. 130). In parallel to the work in Urkosh, between 1993 and 2002, much research was undertaken in Altai by a Russian-Mongolian-

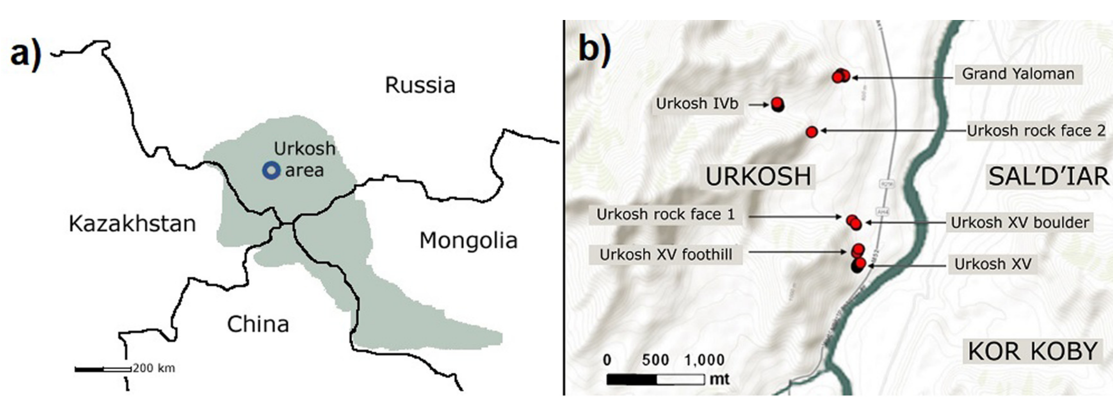

Figure 1: (a) Altai mountain range in grey. The circle indicates the location of the Urkosh area; (b) General map of Urkosh, Sal'd'iar and Kor-Koby with the locations of the test points.

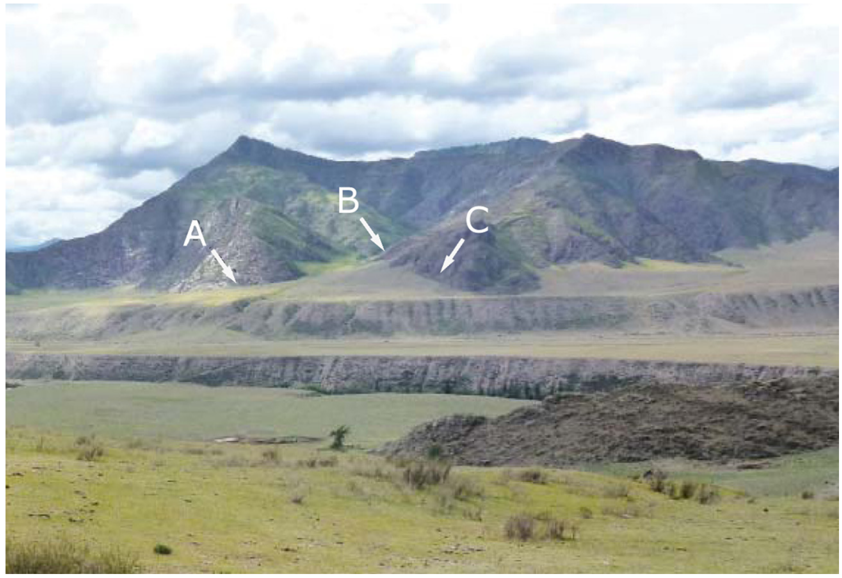

Figure 2: The Urkosh area seen from Sal'd'iar on the opposite side of the Katun River valley. In the background, the Yaloman mountain range and the location of the Urkosh XV (A), Urkosh IVb (B) and Grand Yaloman (C) sites. The Katun River flows through the recessed, narrow valley at the foot of the prominent fluvial terraces in the foreground. Source: Borodovskii et al. (2016, Figure 490, modified and with additions).

American Expedition and collaboration was also established with Japanese colleagues. The result of all these efforts is a wealth of publications, mainly by specialists of the nearby archaeological institutions of Novosibirsk and Kemerovo (Kubarev, 2003), and also from other Russians and researchers of different nationalities (e.g. Jacobson, 1997; Kubarev & Jacobson-Tepfer, 1996).

The plans for the construction of 570 km of the "Power of Siberia-2" gas pipeline through the Republic of Altai, as part of the 6,700 km conduit connecting the Siberian state-owned Gazprom gas fields and China, led to intensive surveys in the second half of the 2000s and, especially, in the early 2010s (Borodovskii, Gorokhov, Kubarev, & Bogdanov, 2016). From the 2000s, the research in Urkosh was continued by Tishkin and his team of archaeologists from the Altai State University of Barnaul, who excavated the mound of Yaloman II (Tishkin & Khavrin, 2004). The surveys in this region have found many different types of archaeological remains, including mounds, kurgans, *ovoos*, stelae, and rock art. The role of the Urkosh area and the whole middle section of the Katun River as an interregional communication network across Central Asia may explain this concentration of archaeological sites, as the area probably acted as an important node between southern Siberia and the territories of contemporary Mongolia, China, and Kazakhstan (O'Sullivan, 2020). Moreover, in the Common Era, especially between the fifth and tenth centuries, the Urkosh region was crossed by a local branch of the Great Silk Road (Chevalkov, 2006).

Regarding rock art, surveys in the Urkosh area identified many new rock art panels and burial mounds from different periods, mainly located on the highest fluvial terraces on both sides of the Katun River Valley (Tishkin & Seregin, 2010; Tishkin, Seregin, & Matrenin, 2016, pp. 7–18, 51–64). Furthermore, the discoveries on the west bank of the river – on the opposite side to Urkosh – where the pipeline was going to run, included the rock art areas of Sal'd'iar and Kor-Koby. In the first, Sal'd'iar (Сальдьяр), an Afanasievo-culture barrow was excavated by Larin (2005). Reused slabs with rock art motifs already carved on them were documented in the burial, while another fragment of a slab with petroglyphs was found in the excavation spoil heap during later work on the pipeline (Borodovskii, 2013, p. 83). Further research in the area revealed that the goats depicted on the slabs were akin to others carved on nearby rock surfaces (Borodovskii, 2013, Figure 2). In addition to the prehistoric remains, further archaeological evidence in the Sal'd'iar area revealed stelae, irrigation channels, and other archaeological structures from different chronological periods ranging from the Bronze Age to the Turkic period. Further to the south, in addition to the Urkosh and Sal'd'iar areas, about 2 km upstream on the same side as the latter, another rock art concentration was identified in the Kor-Koby (Кор-Кобы) area, in one of the tributary valleys of the Katun River (Figure 1b). A concentration of petroglyphs was located amid several prehistoric burial mounds, as well as remains of "Turkic fences" or funeral memorials (Borodovskii et al., 2016, pp. 77–82). For this study, it is worth mentioning that the excavations revealed that during the Bronze Age, the rock art sites of Urkosh, Sal'd'iar, and Kor-Koby were often associated with episodic periods in which fires were lit, pots were used, and sacrifices were performed close to the decorated walls (Borodovskii et al., 2016, p. 78; Surazakov, 1996). This evidence is similar to that found at other rock art sites in Russian Altai (Efremova, 2009; Molodin & Efremova, 2008).

The rock art of the three areas, Urkosh, Sal'd'iar, and Kor-Koby, is similar. The panels are mainly located on vertical cliffs, although carved figures have also been found on large erratic boulders of the same intrusive igneous rock found at the foot of the fluvial terraces close to the riverbed. The chronology is, as usual, one of the hot topics under discussion (Rozwadowski, 2018, pp. 151–167). The Altai Mountains were already being explored by modern humans in the Palaeolithic, and some petroglyphs in the Russian and Mongolian parts of Altai show significant stylistic similarities to Western European Upper Palaeolithic rock art (Molodin, Geneste, Zotkina, Cheremisin, & Cretin, 2019). Consensus regarding the earliest rock art, however, has still not been reached, and many "early" petroglyphs are chronologically ranked between the Upper Palaeolithic and the Neolithic, i.e. up to the second half of the third millennium BC (Jacobson-Tepfer, 2013; Kubarev, 2011; Miklashevich, 2020; Zotkina et al., 2020).

3 The Rock Art Sites Tested in the Urkosh Area

In the Urkosh area, we tested two large sites, Grand Yaloman and Urkosh XV, considered to be sanctuaries by local researchers. Moreover, in order to compare the acoustic results from the two main rock art sites, three minor sites were also measured: Urkosh XV foothill, Urkosh XV boulder, and Urkosh IVb. Finally, the same aim was behind the acoustic testing of two undecorated rock faces that we numbered 1 and 2. All these sites are described briefly in this section.

3.1 Grand Yaloman or Yaloman III

The first rock art site in the Urkosh area considered in this study is Grand Yaloman or Yaloman III. It is located on the northern limit of the Urkosh fluvial terrace, in an area oriented towards the S-SE (coordinates E 086°34.162′, N 50°33.017′) (Figures 1b and 2) (Tishkin et al., 2016, p. 22). The rock art panels were created on several blocks protruding from the foot of the steep mountain slope. Their geology clearly stands out in relation to the rest of the geological material in the surrounding landscape, which consists of coarse, grey-brown Middle to Upper Cambrian flysch. The Yaloman III rock blocks, however, are made of a low-middle Devonian granodiorite displaying a reddish tonality (Figure 3) (Safonova, 2014). This remarkable contrast creates an aesthetic sensorial difference that makes Grand Yaloman stand out in the landscape from a distance. The site was first discovered by the Russian archaeologist Larin Victor Lavrentiyevich in the 1980s, although, as explained above, the first publication was in 1996 by Alexander S. Surazakov, who published figures of archers carved at the site (Surazakov, 1996, p. 82, Figure 1). From the 2000s, the so-called Yaloman archaeological expedition led by Tishkin surveyed an extensive area around the Katun River, which significantly added to our knowledge of the area (Tishkin et al., 2016, p. 11). At that time, renewed research in Yaloman discovered some so-called runic inscriptions, probably from the eighth to ninth centuries, as well as later inscriptions in ancient Uyghur script dated not earlier than the tenth century. The surveys also revealed several groups of funerary structures dated to Late Antiquity and the Middle Ages (Tishkin, Matrenin, & Gorbunov, 2006, pp. 157–158; Tishkin, Matrenin, & Seregin, 2009; Tugusheva, Klyashtorny, & Kubarev, 2014) (Figures 4 and 5). Some of them appeared to be connected to astronomical observations. The cardinal points

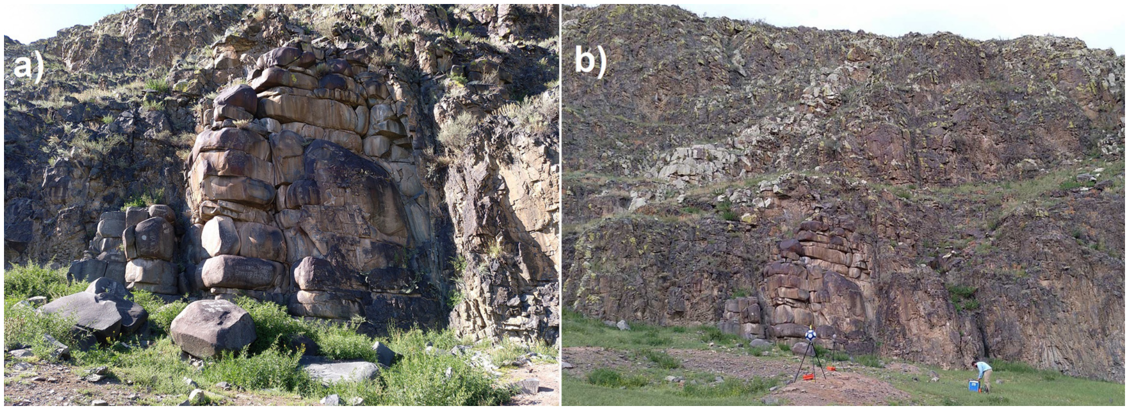

Figure 3: The Grand Yaloman III rock art site. Photographs by M. Díaz-Andreu.

Figure 4: Close-up of some of the carved panels at Grand Yaloman. Photograph by M. Díaz- Andreu.

and the winter solstice appeared to be important to those who used the art (Tishkin, Gienko, & Druzhinina, 2012), although Tishkin himself mentioned that there was a degree of speculation as to the validity of an astronomical interpretation (Tishkin et al., 2016, p. 26, Figure 29).

The Grand Yaloman rock art site comprises several panels dating from the Early Bronze Age to the medieval period, with later additions up to the present day. The oldest and most copious group of rock art figures at this remarkable site consists of approximately 45 carved motifs dating back to the second half of the second millennium BCE (Early Bronze Age). They consist of animal representations, including deer (with a hunting scene), goats, and camels, together with small figures of mushroom-headed archers of about 10–15 cm in height. There are also some riders (Tishkin et al., 2016, p. 23, Figures 17–29).

The impressive figures with mushroom-shaped heads of Grand Yaloman have attracted scholars' attention. They are not unique, as similar motifs are found in a fairly wide geographical area of Siberia, including

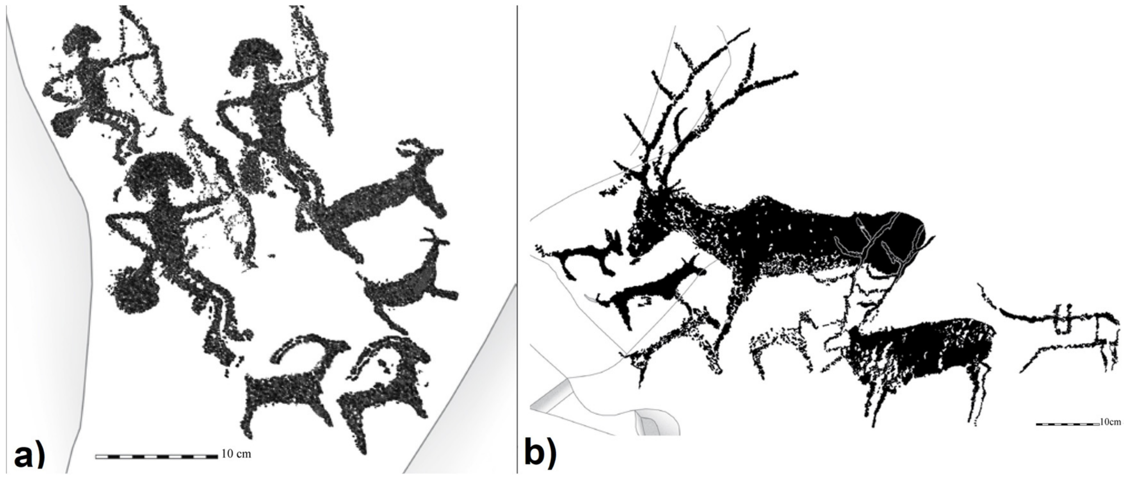

Figure 5: Grand Yaloman. (a) Partial reproduction by A. N. Mukhareva of a rock art panel with archers, a horse (?) and goats. Modified from Tishkin et al. (2016, Figure 20); (b) Partial reproduction by A. N. Mukhareva of the rock art panel with a deer-hunting scene. Modified from Tishkin et al. (2016, Figure 27).

the Russian and Mongolian Altai Mountains, Upper Yenisey Basin, and Chukotka Peninsula (Devlet & Devlet, 2005, pp. 186–202, 243–245; Jacobson, 1997, p. 57, note 24; Kubarev, 1987; Kubarev & Jacobson-Tepfer, 1996, p. xv; Molodin & Cheremisin, 1999). It has been suggested that the archers' body posture would not have allowed them to shoot their arrows accurately (Devlet & Devlet, 2005, pp. 197–198), and that they should instead be interpreted as dancers (Kubarev, 1987, p. 163). The synchronised movement of the Grand Yaloman individuals with a mushroom headdress seems to support this interpretation as a dance scene. Interestingly, these motifs are linked to a specific type of paraphernalia that includes a bow, a rounded object protruding from the archers' sides, and possibly some type of headgear (Molodin & Cheremisin, 1999). Various interpretations have been proposed to date: the zoomorphic tail of an undefined mythological creature, an animal skin bag used as a container for liquids, a shaman's medicine bag, possibly containing some intoxicating fly agaric mushroom whose peculiar shape is mimicked by the head of the archers, a ritual club or mace, or, finally, some type of hunting instrument designed to catch small animals (Devlet & Devlet, 2002, pp. 125–128; Kubarev & Jacobson-Tepfer, 1996, p. xiv). Interestingly, Esther Jacobson argues that the Iron Age rock art in southern Siberia and Mongolia began to be much more narrative than in previous periods, a fact she relates to the development of epics and storytelling (Jacobson, 1997; Jacobson-Tepfer, 2015a,b, pp. 152–190). Moreover, Sovetova makes a connection between the dancing figures in the Siberian rock art of the Yenisei (located to the north of Altai) and epic narration (Sovetova, 2005, pp. 33–36).

The Grand Yaloman site was used for a very long time, as demonstrated by the rock art motifs dating to the medieval and later periods further indicating the site's importance. The Grand Yaloman site, with its rock art motifs marking the remarkable protruding rock surfaces, has been described as a sanctuary (Surazakov, 1996; Tishkin & Seregin, 2010, p. 131; Tishkin et al., 2016, p. 11).

3.2 Urkosh XV

In addition to Grand Yaloman, the second major site in the area is the so-called Urkosh XV. Discovered in 2002 by Tishkin's team and recorded in 2009–2011, Urkosh XV is a vertical wall of orange coarse-grained granodiorite of approximately 7 m × 5 m oriented towards the east (Figure 6, see also Tishkin et al., 2016, Figures 89–92a, 93–97). Its coordinates are E 086°34.284′, N 50°31.948′ (Mukhareva & Tishkin, 2016, p. 90). The panel contains three main figures representing one female deer to the left and two male deer confronting each other to the right. Each is approximately 2 m wide by 1 m high. A possible fawn is found next to the female deer, and, on the other side of the panel, there are six goats, one of them being shot by an archer (Figure 7). At Urkosh XV,

Figure 6: The Urkosh XV rock art site seen from the NW. Photograph by M. Díaz-Andreu.

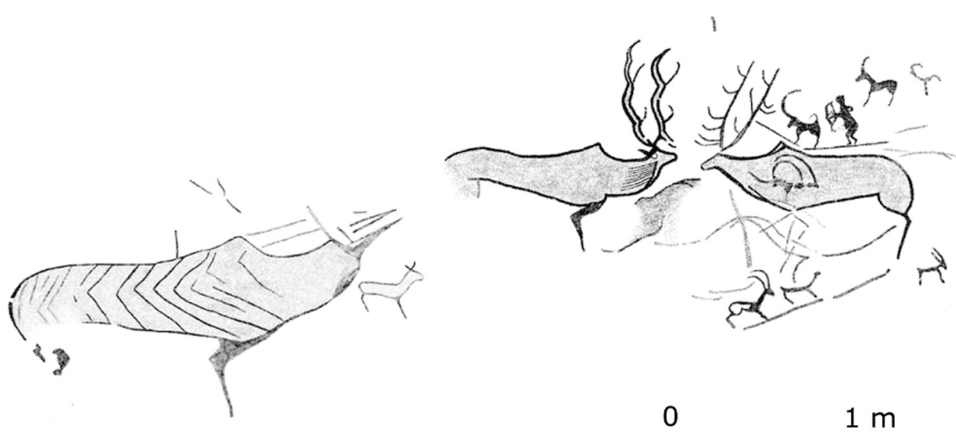

Figure 7: Reproduction of the Urkosh XV rock art panel. Modified from Mukhareva & Tishkin (2016, Figure VII).

the technique used to create the rock art figures consisted of polishing rather than carving, a technique that is not unique to a particular period (Miklashevich & Mukhareva, 2011; Mukhareva & Tishkin, 2016, pp. 93–94). The patina that covers the figures today, together with some natural weathering, makes it very difficult to distinguish them. However, at the time they were being produced, the removal of the superficial layer of iron hydroxides that covered the granodiorite made these motifs look white (Mukhareva & Tishkin, 2016, p. 93). Because of their style, all the figures have been dated to the Early Iron Age, given that they share many similarities with the art of the Arzhan-Mayemir style (e.g. small head, one eye in the form of a circle, protrusion at the withers, and thin legs with the lower part represented by a thin line; see Mukhareva & Tishkin, 2016, p. 99; Sher, 1980, p. 243). Moreover, the inner filling of the deer to the left, connecting lines forming an angle, is common in Saka-Scythian art (Mukhareva & Tishkin, 2016, p. 99).

Urkosh XV is located very close to a group of five small kurgans aligned from SW to NE known as Yaloman XV and dated to between the Chalcolithic and the Early Iron Age (Tishkin et al., 2016, pp. 49–50, Figures 87, 111, 205–206). Tishkin associated Urkosh XV with a series of archaeological remains in the area. He explains that

> The main elements of the Urkosh-XV sanctuary are a large whole plane without drawings – "mirror" a paved platform in front of it, a long lying stone (stele) within the fence of the platform, a plane with petroglyphs, and a small stone niche. There is a barrow nearby with a stone cist of the "Early Scythian" period (Biiken culture), as well as a fence of vertically mounted slabs, dating back to the "Afanasievo" period. It is possible that some other landmarks existed, but they might have been lost during the construction of the Chuysky Tract and quarrying (Tishkin et al., 2016, p. 47, our translation).

As in Grand Yaloman, it seems that some of the archaeological sites in the area were connected to the Urkosh XV panel in relation to astronomical events (Tishkin et al., 2016, Figure 99). Tishkin and Seregin proposed that Urkosh XV should, like Grand Yaloman, be considered a sanctuary (Tishkin & Seregin, 2010, pp. 132, 133).

3.3 Urkosh XV Foothill Minor Site

The Urkosh XV foothill rock panel is on a flat, vertical rock face about 4 m high located in the same foothills some 100 m north of Urkosh XV. It only has a single panel with rock art, whose surface is, unfortunately, flaking away, with at least nine very patinated and difficult-to-see schematic deer of uncertain chronology. The UTM coordinates are E 86°34′18″, N 50°32′02″ (Figure 8a and b).

3.4 Urkosh XV "Boulder"

The Urkosh XV "boulder" is a grouping of several outcrops of different sizes some 250 m north of the Urkosh XV foothill, and about 360 m from the main Urkosh XV panel (Tishkin et al., 2016, p. 43). Only one of these boulders appears to have some engraved animal motifs (Figure 8c) and Tishkin explains that it was chosen for some experimental work related to the removal of lichens (Tishkin et al., 2016, p. 43). Although it is relatively distant from Urkosh XV, the decorated boulder is included by Tishkin et al. (2016, Figure 92b) in the same section explaining the larger site. The coordinates are E 86°34′17″, N 50°32′11″ (Figure 8c).

3.5 Urkosh IVb

The Urkosh IVb rock art panel is about 60 cm high and carved with several ibexes of uncertain chronology (Figure 8d). Its coordinates are E 086°33.580′, N 50°32.836′. It is about 170 m to the west-southwest of Mound 1 of the Urkosh-IV archaeological complex, the first of three recorded in the area (Tishkin et al., 2016, p. 34) (Figure 8d, and Tishkin et al., 2016, Figure 53a and b) (Figure 8d).

3.6 Urkosh Undecorated Rock Faces 1 and 2: Tested Rock Surfaces Without Rock Art

In addition to the minor rock art sites explained above, in order to further compare the acoustic results from the main sites – Grand Yaloman and Urkosh XV – we conducted two further tests in places where the rock faces were good enough to have been selected for rock art creation and yet, we could not identify any remains of rock art motifs on them. They were designated Urkosh Rock Face 1 and Urkosh Rock Face 2. The coordinates of the first are E 86°34′15″, N 50°32′12″ and the second are E 86° 33′36″, N 50°32′50″ (Figure 9).

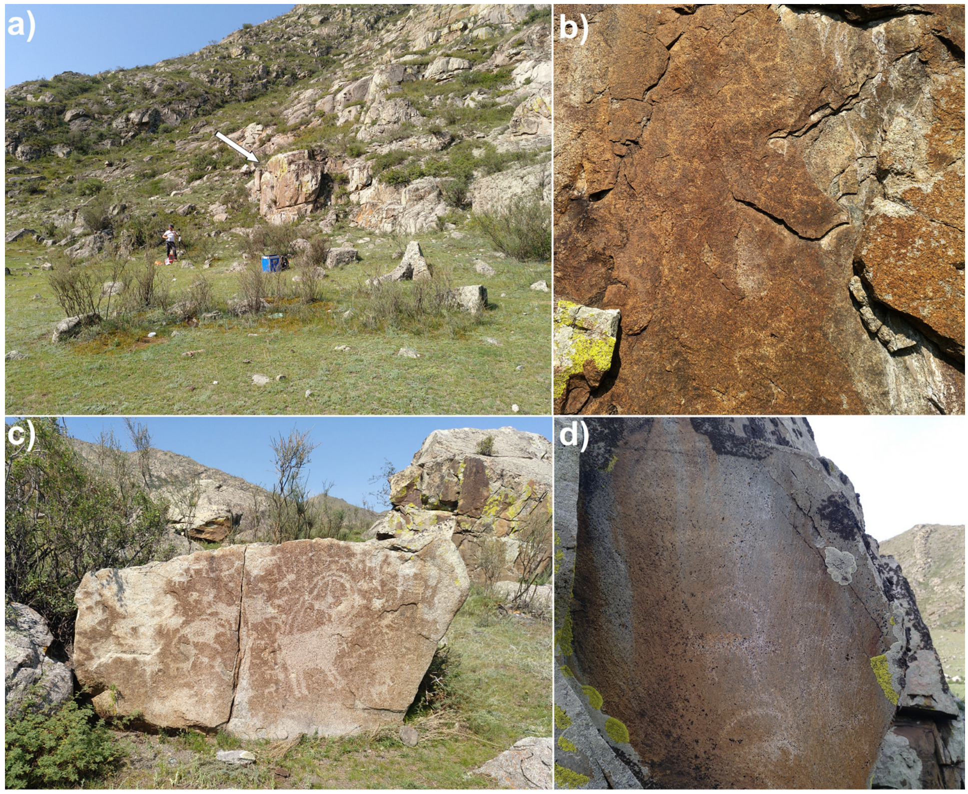

Figure 8: Urkosh XV foothill, Urkosh XV boulder and Urkosh IVb sites. (a) Urkosh XV foothill. The white arrow points towards the panel; (b) Detail of the Urkosh XV foothill rock art panel; (c) Urkosh XV boulder rock art site. (d) Urkosh IVb rock art panel. All photographs by M. Díaz-Andreu.

Figure 9: Urkosh Rock Face sites. (a) Urkosh Rock Face site 1; (b) Urkosh Rock Face site 2. Photographs by M. Díaz-Andreu.

4 Acoustic Analysis

4.1 Methodology

In room acoustics, the traditional method for evaluating the auditory impression of speech, music, and sound is based on the analysis of a set of so-called impulse responses (IRs) (Kuttruf, 2009, pp. 255–261). This methodology provides an objective physical measure of the acoustic response of the site under study, which allows for a quantitative assessment of the acoustic features that objectively describe the hearing experience, including reverberation, sound envelopment, and perceived loudness. Generally speaking, an IR captures the acoustical "signature" of a given place by registering how sound propagates from an emission point (sound source) to a receiver point (microphone). Under fairly general circumstances, sound propagation at rock art landscapes is severely affected by reflections on hard surfaces such as rock walls, cliffs, or canyon slopes. Consequently, in rock art landscapes, sound perception may vary from place to place. In some cases, particular landscape morphologies can even add outstanding acoustic effects such as distinct echoes and long reverberation tails.

In this study, IRs were systematically collected in order to explore the potential association between rock art and localised acoustic responses to speech and music signals. Following the recommendations accepted by the International Organisation for Standardisation (ISO 3382-1, 2009) directive, IRs were measured using an omnidirectional sound source at the emission point producing a sound that covered the range of frequencies of interest.[1] However, as a result of previous studies undertaken by senior Artsoundscapes staff member, Angelo Farina, together with Lorenzo Chiesi (Farina, 2007; Farina & Chiesi, 2016), we introduced a relatively new IR measurement equipment for the omnidirectional sound source. The dodecahedral loudspeaker used did not emit sound from all the speakers simultaneously. Instead, an innovative compact device with 12 individually driven speakers at the emission point was built (Farina, Farina, & Armelloni, 2020). The novelty was that, rather than playing all the loudspeakers together, as required by the ISO standard, the new dodecahedral sound source was controlled by an Arduino board that triggered the impulse signal of one transducer at time, always in the same order. The final result was a set of 12 directional audio signals that later had to be recombined in the post-processing phase to create a directivity polar pattern, from the omnidirectional recommended by the ISO guideline to a variety of sources radiating with arbitrary directivities. It is worth noting that the novelty of this purpose-built dodecahedron loudspeaker is that in the future it will allow, for example, the auralisation of directional sound sources such as organic sounds (e.g. vocalisation) or the specific types of musical instrument used in prehistoric times. The possibilities offered by this technique will be developed in a future article.

At the receiver points, a High Order Ambisonics (HOA) Zylia ZM-1 microphone was used to register the emitted signals. This type of microphone consists of a small sphere equipped with 19 directional capsules whose signals are recorded with the Digital-Audio Workstation Plogue Bidule 0.9777 on a portable laptop (Dell Latitude Rugged 5242). Using the Ambisonics technique, which is based on spherical harmonics, the sound recorded at the receiver point can be spatially encoded and decoded in the post-processing phase (Farina, 2007). In particular, the deconvolution process to obtain the IR from the recordings and the conversion to third and first order Ambisonics were made using a MatLab script specifically designed for this project.[2] The conversion allowed the use of the first channel (W) of the resulting audio file as the omnidirectional IR that met the ISO 3382-1 (2009) standard requirements for calculating monaural acoustic parameters. Each omnidirectional IR was thoroughly analysed with the acoustic software tools ARTA 1.9.4 and EASERA 1.2. The acoustic parameters to be discussed in this article are reverberation time (T_{20}) energy parameters (T_S, D_{50}, C_{80}), and sound strength (G). Such an average value is denoted as 'mid', and it is illustrated by the suffix "m" added to the metric notations.

The data considered in the study consisted of a relevant number of acoustic tests performed during the fieldwork undertaken in August 2019 in the selection of sites in the Urkosh area described in Section 3 (Table 1). In this article, in order to prevent the influence of source and receiver positioning from affecting the results of the acoustic metrics and consequently the conclusions, IRs registered at comparable points between sites have been selected, i.e. in which source and receiver positioning followed a similar criterion considering both the spacial distribution and morphological characteristics of the different sites. We will be using the acoustic tests performed in front of the rock art panels. Each of the tests referred to a particular pair of source and receiver

1 In our fieldwork, we used as sound impulse a 10 s long Exponential Sine Sweep ranging from 20 Hz to 20 kHz with an emission SPL of 90.9 dB(A) at 1 m.

2 https://github.com/xorgol/MIMO_Matlab.

Table 1: Summary of the tests performed in Urkosh area

Site name	no. of acoustic measurements
Grand Yaloman	5
Urkosh XV	7
Urkosh XV foothill	3
Urkosh XV boulder	1
Urkosh IV b	3
Urkosh face 1	1
Urkosh face 2	1

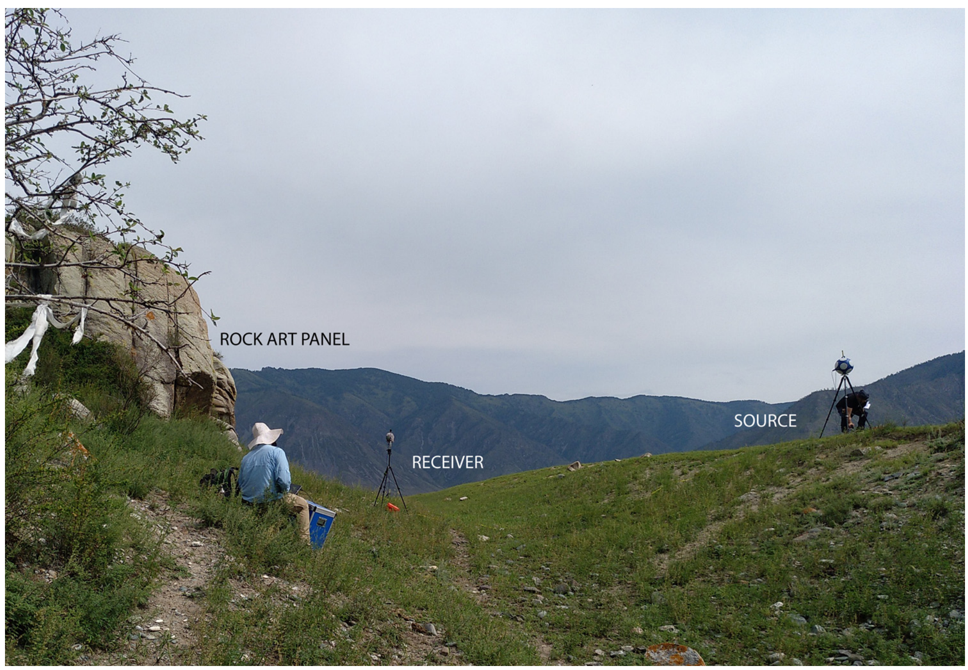

Figure 10: Photograph taken during fieldwork at Urkosh XV. Photograph by M. Díaz-Andreu with additions.

locations (Figure 10). During the IR measurement, the sound source was positioned at a variable distance of 7–10 m from the rock surface, depending on the available space and morphology of each site. The receiver was positioned in the vicinity of the paintings, 10 m outwards from the sound source. Its height was set to 1.6 m above the ground to simulate a listening position comparable to the average ear height of a standing person. This S-R configuration covers the hypothesis of one sound source, and a small group of listeners.

4.2 Results

Is it possible to evaluate how the acoustic conditions in which particular intangible cultural practices may have been produced in the areas adjacent to the rock art panels? We will attempt to answer this question by analysing the results of the acoustic parameters mentioned above: reverberation time (T_{20}), clarity of speech (T_S, D_{50}), and music (C_{80}), and sound strength (G). The first parameter mentioned, T_{20} (s), is the main descriptors of the way we experience the acoustic environment of a site (Beranek, 2004), at least, by our Western standards today. It is calculated from the decay of sound in the space once its emission has stopped (ISO 3382-1, 2009). A space is often referred to as being "live" if it is very reverberant or, if there is little sound

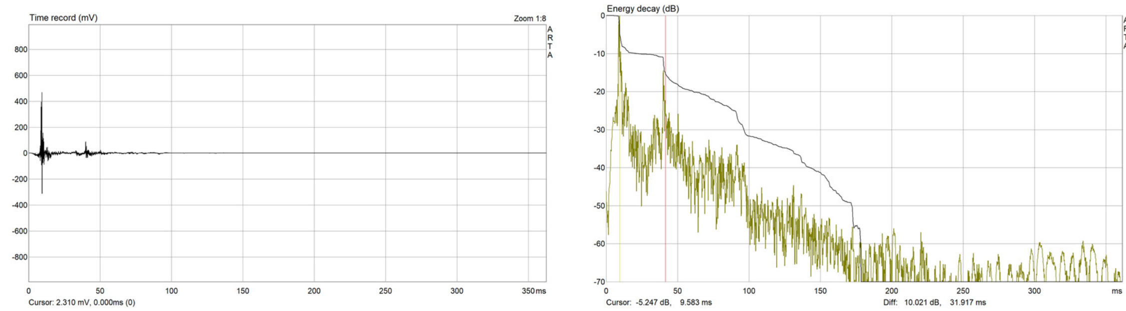

Figure 11: Omnidirectional impulse response measured at Urkosh XV (left) and its energy decay (right).

reverberation, as "dry" or "dead." Optimal T_{20} values can vary by several orders of magnitude depending on the size and purpose of the places. For example, for concert halls, optimal values fall between 1.8 and 2.2 s (Barron, 2009, p. 66), whereas for medium-sized multi-purpose halls, it varies between 1 and 3 s (ISO 3382-1, 2009).

Reverberation in the studied area is expected to be minimal due to the open field conditions during the measurements and the rugged terrain surrounding the rock faces where the carvings are located. Specifically, the lack of diffuse conditions results in nonlinear energy decay of the IRs, preventing an accurate estimation of reverberation parameters (Table 1). As an example, Figure 11 shows the IR and the early decay curve, also known as the Schroeder Integral (Schroeder, 1965), obtained at Urkosh XV. The centre time, T_S (ms), is typically used as an indicator of sound clarity. Nevertheless, in open spaces, this parameter, which a priori does not differentiate between early and late sound, becomes particularly relevant, being also useful to detect the presence of late reflections or echoes (Paini, Gade, & Rindel, 2011; Rindel, 2023). The very low values obtained at the studied sites indicate the absence of late reflections and reverberant energy, suggesting that mainly the direct sound and very early reflections, presumably from nearby rocks, reach the listeners in that area (Dietsch & Kraak, 1986). In any case, the absence of a proper reverberant tail at the surveyed sites indicates that these sites can be considered "dry" in terms of sound perception, potentially facilitating speech transmission (Ando, Okura, & Yuasa, 1982).

Was the lack of a proper reverberant tail unfavourable for the production of music in the acoustically tested sites at Urkosh? In the case of music, it is true that certain compositions, musical genres, beliefs, and aesthetics demand high reverberation values (see, for instance, Ahnert & Steffen, 1993, pp. 79–160; Levin & Süzükei, 2006, pp. 37–40; Schiltz, 2003), but a wide range of musical practices, such as singing in the forest before hunting, are performed in open field conditions all over the world (Zelenin, 1929), as well as singing in the landscape using natural sounds (Levin & Süzükei, 2006, pp. 29, 185, n40 in 253). Moreover, music with fast tempos and rapid, complex lyrics, or that in which understanding the words is particularly important, may benefit from low T_{20} values.

Did music and speech clarity play an important role in the selection of the spaces? Energy parameters related to the perceived clarity of sound may define spaces suited for performances that included singing and instrumental music, as well as verbal communication events such as discourses or even storytelling. In this study, the sound definition parameter D_{50}, is used to assess the intelligibility of speech and singing[3] (Ballou, 2008, p. 154), whereas the music clarity parameter, C_{80}, is related to the impression of transparency in fast-tempo music pieces and the ability to recognise musical detail. In general, it can be considered that this feature increases proportionally to the clarity value (Carrión Isbert, 1998, p. 184). These energy metrics are computed based on the ratio between the sound energy captured within a predetermined time frame following the

3 It has to be borne in mind that conditions for speech intelligibility also depend on the energy levels of the sound produced and the energy level of the background noise at each particular sound event.

Table 2: Acoustic parameter results in the Urkosh area

Test point	Rock art[1]	T_{20m} [2]		T_{Sm}	D_{50m}	C_{80m}	G_m
		(s)	*r*	(ms)	–	(dB)	(dB)
Grand Yaloman	•	Na	−0.85	4.40	0.98	19.6	0.30
Urkosh XV	•	Na	−0.96	7.32	0.99	27.5	0.85
Urkosh Foothill	•	Na	−0.92	3.44	0.99	32.0	0.20
Urkosh Boulder	•	Na	−0.91	6.23	0.99	30.9	0.55
Urkosh IV b	•	Na	−0.90	3.46	0.99	32.4	0.25
Rock face 1	o	Na	−0.90	5.37	0.96	18.6	0.25
Rock face 2	o	Na	−0.94	2.95	0.99	25.1	0.10

Mid values are frequency averaged at 500 and 1 kHz frequency bands as defined in the ISO3382-1 (2009).
[1]Filled dots represent sites with rock art, and white dots represent spots without rock art in the area.
[2]A reliable calculation of T_{20} needs a correlation coefficient, *r*, from −0.995 to −1, therefore, exact values are not provided.

arrival of the direct sound (50 ms and 80 ms, respectively) and the sound energy captured thereafter (Ahnert & Steffen, 1993: pp. 24–26; Ballou, 2008: pp. 159–160). Definition values nearing unity are associated with optimal conditions for clear transmission of spoken messages within a given space (ISO 3382-1, 2009). Besides, the recommended C80 values of a venue are between −4.6 and +8 dB, although this range strongly depends on the type of music (Ahnert & Steffen, 1993, pp. 24–26; Reichardt, Abdel Alim, & Schmidt, 1974; Barron, 2005; Ballou, 2008, p. 160).

Looking at the results obtained at the Urkosh area sites as regards speech transmission, it is important to note that D_{50} values are close to 1 at all the sites studied (Table 2). Values for music clarity (C_{80}) are also very high, as most cases exceed 25 dB, which are in any case much higher values than those recommended for performance venues with a wide range of Western music styles.

Moreover, we also calculated strength (*G*), i.e. the parameter that relates with the perceived loudness in a place. Strength measures how the landscape contributes to the sound level produced by a particular sound source at each receiver position. Technically, this parameter is calculated as the ten-fold logarithmic ratio of the sound energy captured at a particular receiver location to the energy measured at a distance of 10 m from the same acoustic source in the free field. In this case, the *in situ* calibration method was used to calculate the reference signal (Katz, 2015; Santos da Rosa et al., 2023). In general terms, *G* values between 1 dB and 10 dB are usually considered favourable for musical and speech performances in closed spaces (Ballou, 2008: , p. 153). The question to answer at this point would be if in the Urkosh area, the places to be carved were selected because they offered a stronger perception of loudness. The results, however, do not seem to indicate that this was the case. The strength parameter was around 0 dB in all cases. Considering that the distance between the source and the receiver in all the tests was 10 m, this indicates that there is no perception of a natural amplification of sound caused by the site. In the Lower Chuya area, however, strength values seemed generally higher but still not fully consistent (Díaz-Andreu et al., 2023).

The results of our acoustic tests, therefore, show that the Urkosh landscape in general had advantageous conditions for an unhindered perception of oral communication. Furthermore, in the hypothetical scenario in which the music played in the studied sites would have had a fast tempo, the lack of reverberation may also have favoured its proper transmission all around it.

However, as there are no significant differences between the results obtained in the two major rock art sites, the minor rock art sites, and those next to rock faces without any sign of carvings, we have to conclude that there is no evidence for acoustics to be considered an essential element for the selection of the places to be carved. Instead, we would like to suggest that the geology of the places may have been key to their selection. We have already commented above about the extraordinary visual aspect of Grand Yaloman and Urkosh XV, the major sites, the former because of the different nature of rock and the fact that the rock blocks protrude out of the mountain, and the latter due to the grandiosity of the blocks that make it up. As argued in Section 5, however, the results of the acoustic tests are still a good basis for discussing certain aspects that may have been linked to the sensations people experienced when present at the rock art sites.

5 Music, Storytelling, and Rock Art?

Were the acoustic conditions in the Urkosh rock art area beneficial for the art producers and users? As we argue below, we believe they were. Information from the ethnographic studies undertaken in Siberia from the nineteenth century indicates that singing and storytelling were fundamental for the local populations. This is rarely mentioned in archaeological publications. As stated in the introduction, the emphasis on the material in the most common definitions of archaeology usually leads archaeologists to focus on the tangible rather than the intangible aspects of culture. Storytelling and music are examples of these intangible cultural productions that archaeology usually ignores, despite their critical social role. Both are usually communal and integrative and have the ability to prompt powerful emotional responses in participating individuals (Morley, 2009, p. 161). Music stimulates and reinforces group cohesion, promotes group interaction, alters mood promoting group morale (thanks to the release of the oxytocin hormone), and fosters communality. Furthermore, it makes explicit the identity of the group as a whole and the individual's belonging to the group (Morley, 2013, pp. 279–293). Participants' contribution to music is allowed by a process of entrainment, both in cases in which participants contribute to music-making and in those in which engagement with music is apparently passive, but the individual is, for example (perhaps mentally) tapping the rhythm (Cross, 2016). Storytelling, the art of narrating ritualised or fictional stories from memory, has also been seen as a behaviour beneficial for the group, as it boosts social collaboration. Indeed, among mobile populations (hunter-gatherers and itinerant herders), one of the adaptive functions of storytelling may be to organise cooperation (Smith et al., 2017). It has been claimed that this was an essential step in human evolution (Boyd, 2009; Dunbar, 2014; Smith et al., 2017). Storytelling has a greater potential than music for conveying information and direct social behaviour by transmitting information about social norms (Smith et al., 2017, p. 3) and the supernatural dimensions of cultural and natural landscapes and the wilderness (non-human beings) (Valk & Sävborg, 2018, p. 7).

Several authors have linked storytelling and rock art. The earliest depiction identified with storytelling is found in the cave of Leang Bulu' Sipong 4 in Sulawesi (Indonesia) dated to about 21–14 ka. It represents a hunting scene in which several therianthropes are hunting wild pigs and dwarf bovids, interpreted as "the oldest pictorial record of storytelling and the earliest figurative artwork in the world" (Aubert et al., 2019). From a much later date we find examples in Scandinavia, where some archaeologists have suggested a connection between Finnish folklore stories and rock art (Bolin, 2010; Lahelma, 2012). Discussing northern Scandinavian rock art, Michael Ranta and his colleagues have claimed that much of it may display "stories based on real-world experiences of hunting, filtered through a prevailing cosmography" (Ranta, Skoglund, Persson, & Gjerde, 2020, p. 229). One of the writers of the article had already mentioned some years earlier that:

> Stories were told and retold over and over since they were manifested in the rocks. New stories were constantly added…Stone Age rock art includes stories of reality and cosmology. Rock art seem to be narrating an intertwined cosmography of Stone Age hunter-gatherer lives. (Gjerde, 2010, p. 454)

The link between storytelling and rock art has also been seen in Southern Africa and Australia. In the first area, the ethnography recorded by Wilhelm and Dorothea Bleek and Lucy Lloyd in the late nineteenth and early twentieth centuries provided much richer information about the mythology of the indigenous populations who could still understand the meaning of the images. This has been the focus of a series of sophisticated analyses by José de la Prada Samper who, in a variety of studies, has made informed interpretations of the art based on modern Kalahari ethnographies and the archive created by Bleek and Lloyd of |Xam oral literature and ethnography (de la Prada Samper, 2014a,b; de la Prada Samper & Hollmann, 2017). In Australia, Senior Traditional Owner Jeffrey Lee explained that the area of Burrungkuy was a focal point for many clans in the area:

> Burrungkuy is an area where family and all the clans come together and share their stories, share their knowledge, teaching the younger generation how to hunt, how to paint, how to find bush tucker, all that was happening here. Everybody from everywhere, all clans, used to come here and share their knowledge and their songs and dance, passing that on to us […]. (May et al., 2020, p. 200)

According to Sally May and colleagues, rock art functioned as storytelling, recounting narratives about, for example, an ancestral being breaking the incest laws (May et al., 2020, p. 205). Interestingly, paintings were used to illustrate stories. An informant who was an infant at the time of the painting being produced by her father explained that the depiction of stories in rock art was common for girls and boys to learn about both ordinary as well as mythological events and stories (May et al., 2020, p. 207).

What do the sources tell us about the connection between music, storytelling, and rock art in Siberia and, in particular, in the Altai Mountains? Scholars such as Esther Jacobson-Tepfer have indeed argued that rock art scenes in the Mongolian Altai show a visual narrative that seem to indicate oral narrative (Jacobson-Tepfer, 2015a,b, for earlier publications by the same author and others see Jacobson & Kubarev, 1994). The literature about music and storytelling is abundant, referring to Siberia generally (Dobzhanskaia, 2017; Harris, 2017; Lavrillier, Dumont, & Brandišauskas, 2018; Musch, 2008; Reichl, 2001), Tuva (Taube, 2008; Van Deusen, 2004), Khakassia (Pegg, 2006; Pegg & Yamaeva, 2012), Gornaya Shoria (Funk, 2019), the Kemerovo Oblast (Funk, 2020), and the Republic of Altai (Agarkov, 2016; Harvilahti, 2000). Among those who have explored the link between music and storytelling, Kira van Deusen's study of the shamans and storytellers in Khakassia in the 1990s is particularly interesting. Despite the fact that her informants belonged to the second or third generation educated under Russian's rule, she argued that:

> stories are part of the complex of spiritual and religious beliefs and practices that have evolved from ancient times in relation to the natural environment and way of life. Everything is imbued with spirit – people, animals, rocks, trees, sky, mountains, sacred springs, lakes, and rivers – all part of the living essence of the planet. Both women and men may be selected by the spirits of nature and of their ancestors to become shamans, storytellers, other kinds of healers, diviners, or ceremonial leaders (Van Deusen, 2004, p. xii)

One of her informants, the shamaness Tania Kobezhikova, took her to the Sunduki mountains where some rock carvings were used to narrate stories (Van Deusen, 2004, p. 5). The author argues that storytellers are more appreciated than shamans, who are feared because of their connections to the spirits of the dead (Van Deusen, 2004, p. 76). Van Deusen also explains that shamans are often women in most of Turkic and Mongolian Siberia, whereas storytellers are always men. However, there is a partial exception in Khakassia, where in the past, women could recount heroic epics, but were not allowed to take part in khai or throat singing (Van Deusen, 2004, p. 90). In the case of storyteller Slava Kuchenov, we are told that his initiation occurred at the hands of the mountain spirits, as is usually the case in southern Khakassia, a situation that "often happens at the confluence of two rivers, which is known to be the home of the *khai eezi*," the spirit master (Van Deusen, 2004, p. 78).

Closer to Urkosh, in the Karakol Valley, 200 km to the north of our case study area, Pegg and Yamaeva (2012) tell us about rituals performed in a *Kuree* temple by Ak Jang (White Faith) practitioners in 2006 (see also Bat'ianova, 2007; Ekeev, 2014; Halemba, 2003). Interestingly, the two major annual festivals are described as making reference to sound. The authors expound that:

> Two annual rituals held in hidden open-air mountain temples (kuree) are central to Ak Jang. Jazhyl Bur ("Green Leaves") is held in spring when "Altai's ear opens" and the mountains' spirit-owners awaken – an event heralded by the first "sound of the sky," thunder. Sary Bur (”Yellow Leaves") is held in autumn when requests for "blessing-fortune" (alkysh-byian) are made for the approaching difficult winter before "Altai's ear closes" and the mountains' spirit-owners sleep (Pegg & Yamaeva, 2012, p. 293)

And mention that in the rituals, performances are undertaken that

> include ritual bodily movements, songs, and oral poetry that include epic and spiritual imagery and motifs, and practices that root participants historically and situate them within the cosmos. In addition, textual improvisations link them to contemporary local and global worlds (Pegg & Yamaeva, 2012, p. 294).

It is unlikely that the details of the performances enacted today in the temples located high in the sacred mountains directly reflect those held in the prehistoric and early historic periods. Nevertheless, this and all other anthropological accounts give us clues as to the types of gatherings that may have taken place at the rock art sites in the Urkosh area, especially in front of the two sanctuaries discussed in this article, Grand Yaloman and Urkosh XV. As explained above, the excavations of the sites have indicated episodic periods during the Bronze Age with evidence of fires, the use of pottery, and the performance of sacrifices close to the rock art panels. Given their location near a major trade route and one of the most important rivers in the area, they were probably visited more often, and the events held at them may have been less religiously charged than at the temples visited by Pegg and Yamaeva. However, in the ontological worldview of the rock art creators and those who experienced the rock art places, the rock itself may have been alive, while the singers and storytellers recounted the mythology that was the basis of social cohesion. In Altai, and generally among many Turkic nations in southern Siberia, mountains are believed to be inhabited by spirits, and different rituals are conducted to access the spiritual realm situated inside rocks (Rozwadowski, 2017). Furthermore, ethnography also shows that the whole Altai, including its mountains, rocks, rivers, lakes, and trees, was seen by its indigenous inhabitants as a living organism (Rozwadowski, 2021).

6 Conclusion

In this article, we have described our archaeoacoustical research at the rock art landscapes of Urkosh, an area by the Katun river in the Altai Mountains, specifically in the Republic of Altai. The rock art at our sites is dated possibly from the Neolithic (fifth and fourth millennia BC) and definitely after the Chalcolithic, from the Early Bronze Age (second half of the third millennium BCE). There is another important phase dated to the Early Iron Age and the medieval period with later additions up to the present day. The acoustic tests were undertaken at two major sites, Grand Yaloman and Urkosh XV, three minor sites, and two undecorated rock faces. The methodology followed was based on the IR method, using a dodecahedral loudspeaker as a sound source and an HOA Zylia ZM-1 microphone as sound receiver. Of the parameters discussed, reverberation (T_{20}), sound strength (G), speech, and music clarity (T_S, D_{50}, C_{80}), only the last provided consistent results.

The values for speech (D) and music (C_{80}) clarity obtained by our acoustic tests indicate that all sites tested, without exception, have extremely high values for those acoustic parameters, as expected in open field conditions. Regarding speech transmission, all D_{50} values are close to 1. Values for music clarity (C_{80}) are also very high, as most of the cases exceed 25 dB, values much higher than those recommended for performance venues with a wide range of music styles. The results indicate that in all rock art sites, the acoustics of these open spaces were favourable for the cultural practices of storytelling, both in the form of speech and singing, in which understanding the words was particularly important. Furthermore, although certain reverberation is essential for the enjoyment of music according to the contemporary standards, we would like to argue that the cultural practices involving instrumental music or rhythms may benefit from the acoustic of the studied sites on a hypothetical scenario in which minimal distortion of the dynamic contrasts, articulation, and rhythm of music were desirable. The selection of which rocks to carve, and which sites were deemed for sanctuaries, however, went beyond the sense of hearing to include other aspects such as the geology and shape of the rock.

Therefore, although the acoustic parameter results of our archaeoacoustic tests do not explain why the art was produced in particular locations, they do suggest that these manifest the conditions in which cultural practices such as storytelling and music could have taken place in them. This hypothesis is based in the first place on the information gleaned from ethnographic sources that indicate the importance of both cultural practices in Siberia and, in particular, in the Altai Mountains. It is also based on the results of the excavations undertaken at the Urkosh rock art sites and in the nearby areas of Sal'd'iar and Kor-Koby. These led archaeologists to hypothesise that fires were lit at different times, pots were used, and sacrifices were performed close to decorated walls. Thus, we can see a plausible scenario in which people sat around fires, as they have done until recently, recounting stories and singing. The link between rock art, storytelling, and music is not unique to the Urkosh area. It has also been put forward for other places in the world, as explained in this article. Such connections show that archaeology has the tools to propose the existence of intangible cultural productions such as storytelling and singing in areas where rock art is produced and experienced.

We suggest that paying attention to sound allows a deeper insight into how the communities of the past lived and understood their worlds. This does not mean that there may have been other reasons such as orientation and viewshed that also serve to explain why the carvings were made in particular locations, as Jacobson-Tepfer (2019) has suggested for the Mongolian Altai. Importantly, in our particular case study, we have been able to propose practices that were beneficial to the communities that performed them. Cultural practices such as those discussed in this text – storytelling and singing – are critical to the promotion of group-beneficial behaviour and encouragement of social cooperation. We would like to end this article by insisting on the new possibilities opened up by archaeology thinking about sound at archaeological sites.

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