Acoustic Measurements at the Rock Painting of Värikallio, Northern Finland

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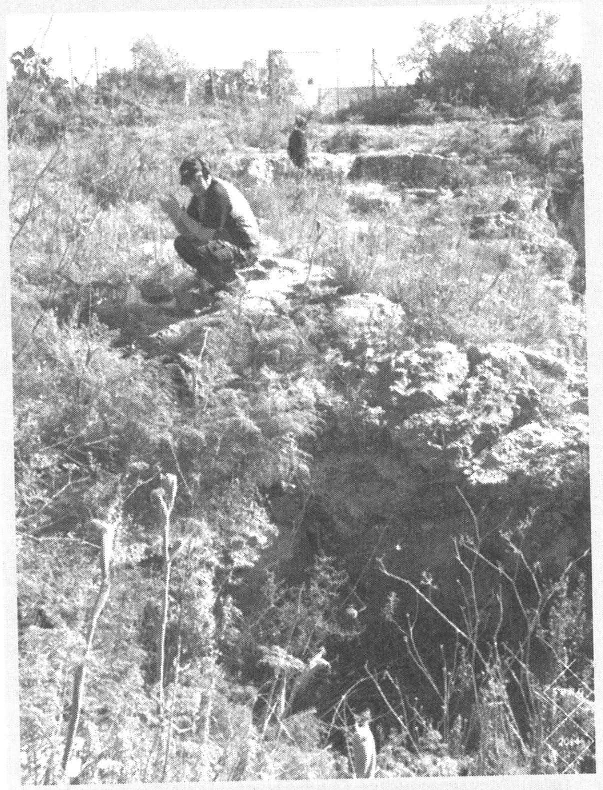
BONUS REPORT: Analysis in Gozo



As part of the research carried out on some of Malta's Neolithic temples, we performed some testing on the sister island of Gozo with very good results especially in the Xaghra stone circle.

The Xaghra stone circle was investigated in a joint archaeological collaboration between the University of Malta and the University of Cambridge between 1987 and 1994. Following this excavation, it was then covered again to preserve its characteristics. Like the Ħal Saflieni Hypogeum on Malta, it was adapted to become a burial place by the same community who practiced its rites in the nearby temple of Ġgantija around the period 3,600-2,400 BC.

The Temple of Ggantija was devoid of underground vibrations, however like Tarxien temples on Malta, nearby Xaghra Stone Circle appears to be a real nerve center of vibrational energy from underground.

This energy is a mechanical vibratory stress that appears to have a broad peak, reaching between 25Hz and 34Hz. It is extremely powerful, more or less comparable to what was found in the temples of Tarxien, but with a slightly longer high frequency range and oscillating just a little bit. Its origin is to be found in the movement of friction between the African and Eurasian tectonic plates close to the archipelago of Malta.

The broad peak at Xaghra Stone Circle seems to intrude in the field of infrasound and in the audible band comfortably up to 40Hz. At this frequency, this vibration is clearly perceptible to an attentive ear and for those who are more sensitive, via the vibrator sensors of body (Meissner mechano-receptors).

Our measurements were carried out in two main locations: a deep well on the side of the walkway leading to a stone staircase that leads to the central hall of the hypogeum; in a collapsed cave that overlooks the main hall of the Hypogeum (A and B respectively on the above image). The ultra-sensitive microphones (Sennheiser MKH 3020) were dropped from the surface without going into the deep wells because this is expressly forbidden by the authorities. In this way the shielded and sufficiently long coupled cables were left suspended so that the microphones did not touch the ground. This was done in this way in order to avoid friction with the ground by the microphones which would have led to the generation of spurious noises affecting the recordings.

In both locations (at about twenty meters from each other), the same low vibrational frequency as an engine in motion was detected. The sound is more likely to be attributable to the underlying tectonic movements as opposed to underground streams, given the scarcity of this natural element in the Archipelago of Malta. In the vicinity of the megalithic circle there was no factory or human activity capable of generating a noise of this frequency, that we were aware of.

How did the ancient megalithic civilization become aware of the vibrations present in this area and the caves at Xaghra stone circle? We propose a simple answer, given the high noise level of those frequencies present in the human hearing spectrum they would have been heard by placing an ear to the ground for the transmission of vibration via bone conduction.

It is likely that these vibrations, close to the rhythm of brain wave frequency, created a sense of exaltation and mysticism in those present. When it was intact, it must have acted as a sound box for someone engaged in prayer or meditation. Probably he felt himself enveloped in the sounds of the womb of the Mother Goddess, and in touch with the depths of the planet.

Paolo Debertolis, Nina Earl - April 5th, 2014

Acoustic Measurements at the Rock Painting of Värikallio, Northern Finland

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ABSTRACT: In Northern Finland, by the rock painting of Värikallio (ca. 3000–500 BC), several echoes can be heard. The most remarkable of these appear to be originating from the painted rock itself. The article presents the first results of the research project that seeks to explore the role of sound in the development and use of Finnish rock art and Sámi offering sites. Field recordings, made at the site of Värikallio in summer 2013, are analyzed with a sound analysis and visualization toolkit, and interpreted with the help of GIS data and a 3D model of the site. A probable depiction of a drummer, identified in the painting in the course of the fieldwork, provides a further clue to the significance of sound rituals at rock paintings.

KEYWORDS: Rock Art, Acoustics, Northern Europe

1. Introduction

Some 140 prehistoric open-air rock paintings are known from Finland, forming a distinct tradition within the wider phenomenon of Fennoscandian hunter-gatherer rock art (Lahelma 2008; Gjerde 2010). The paintings are located on steep lakeshore cliffs, often in narrows left between the mainland and an island, straits leading from one lake to another, or narrow canyon-like lakes. Such locations, possibly featuring an anomalous soundscape, inspired the French musicologist Iégor Reznikoff (1995) to conduct some simple acoustic tests (singing, clapping of hands and counting the echoes) at two Finnish rock painting sites and propose that sounds – echoes in particular – may have played a role in the location of Finnish rock paintings. Some later studies (e.g., Lahelma 2010) have embraced the idea and more robust methodology for investigating the matter has been developed by Waller (1993; Waller *et al.* 1999) and Díaz-Andreu & Garcia Benito (2012), among others. Inspired by this research, and by clues associating sacred sites with acoustic phenomena in the ethnography of the Sámi of Northern Finland (Lahelma 2010, 52–54; Äikäs 2011, 84–88), we decided to test this hypothesis and document the echoes at the rock painting site of Värikallio through a series of controlled recordings.

Värikallio (or 'Colour Rock') lies in the Hossa wilderness park in the north-eastern part of the country, a rugged area far from any major population centres, with a landscape of moraine ridges, elongated canyon-like lakes and largely pristine boreal forests. The paintings have been made on a smallish, southwest -facing cliff rising at the eastern end of Lake Somer (Figure 1) (Taavitsainen 1979). A second, smaller rock painting site lies nearby, but most other sites are located in the Finnish Lake District more than 350 km to the southeast. With regard to the number and range of figures, Värikallio is one of the largest and most important rock painting sites in Finland. The figures mostly depict simple stick-figure cervids (elk or wild reindeer) and human figures, possibly also some beavers or lizards. Because of blurred contours, counting the exact number of the images is an extremely difficult task, but a conservative estimate would be around 40–50 (Lahelma 2008, appendix 2).

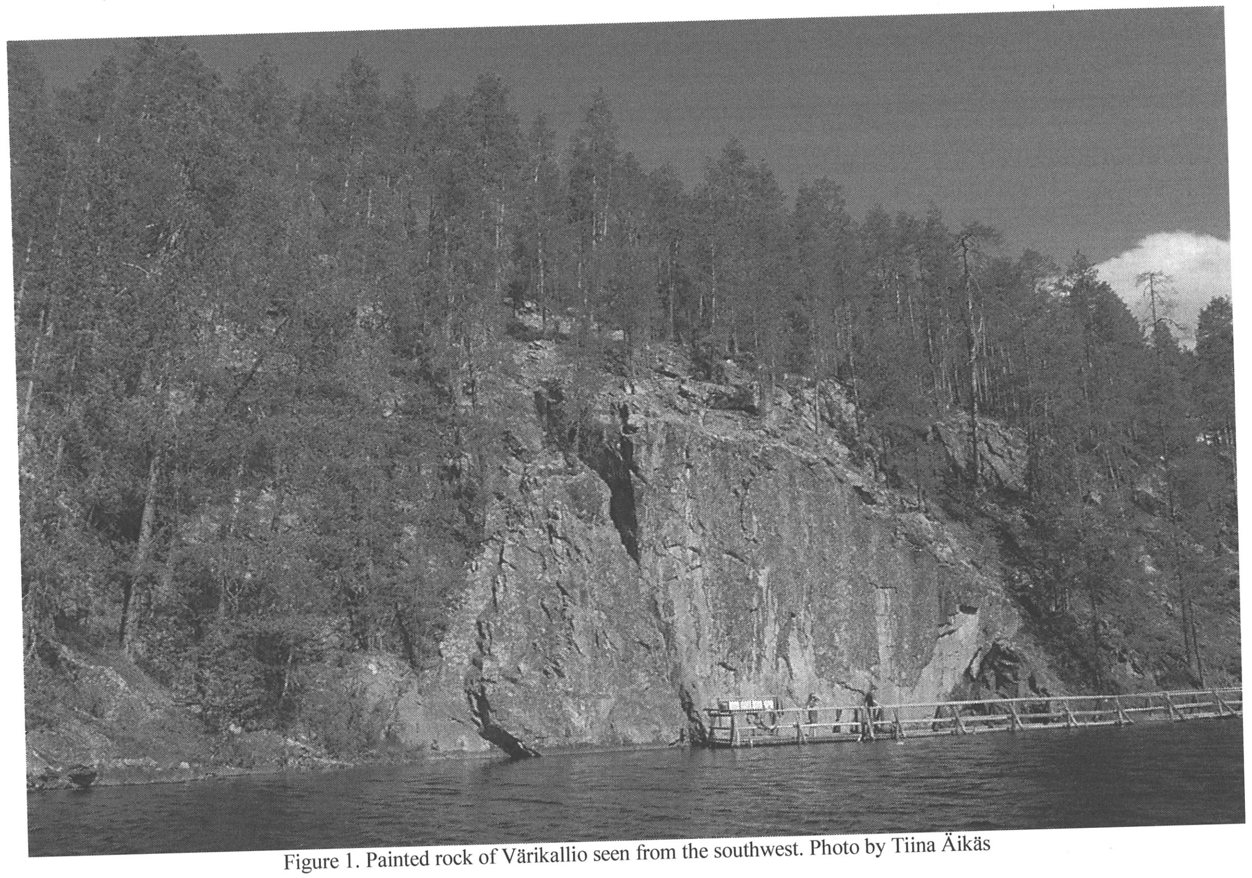

Figure 1. Painted rock of Värikallio seen from the southwest. Photo by Tiina Äikäs

Unlike many other rock art traditions, the dating of Finnish paintings is comparatively well established (e.g., Jussila 1999; Seitsonen 2005). The freshwater basins of the Finnish interior are subject to post-glacial isostatic land uplift and tilting, as a result of which many sites originally painted at water level are now as much as ten metres above the present surface. When the hydrological history of the lake is known, a probable dating can be offered to the painting with the aid of geological shore displacement curves. According to present understanding (see Lahelma 2008, 33–41), the rock painting tradition falls between ca. 5200 and 1000 BC.

However, at Värikallio the images occur between 20 cm and 2.5 m above the present surface of the lake, suggesting that water levels have not altered greatly during the past millennia. This was a prime reason for choosing the site for acoustic testing, as the acoustic properties of the site should have remained unchanged, but the implication is that shore displacement chronology does not apply. The style of the paintings is somewhat distinct from paintings further south, suggestive of a different cultural affiliation, but similarities are strong enough to place the site within the wider Finnish rock painting tradition and its chronological framework. The stick-figure cervids depicted at Värikallio are generally a late feature in Finnish rock art, as is the lack of boat figures (Seitsonen 2005; 2008). Thus, the site can tentatively be dated to the Late Neolithic or Early Bronze Age (ca. 3000–500 BC), although in the absence of direct chronometric dates the dating is admittedly very uncertain.

2. Methods

The fieldwork was conducted in August 2013, in the course of a single day. A windy morning and resulting currents of the lake hindered the work, although the acoustic recording was carried out in calm and windless weather in the evening. The recording took place onboard a rowing boat, which made it difficult to keep the measuring equipment stable and to stay still at the measurement points.

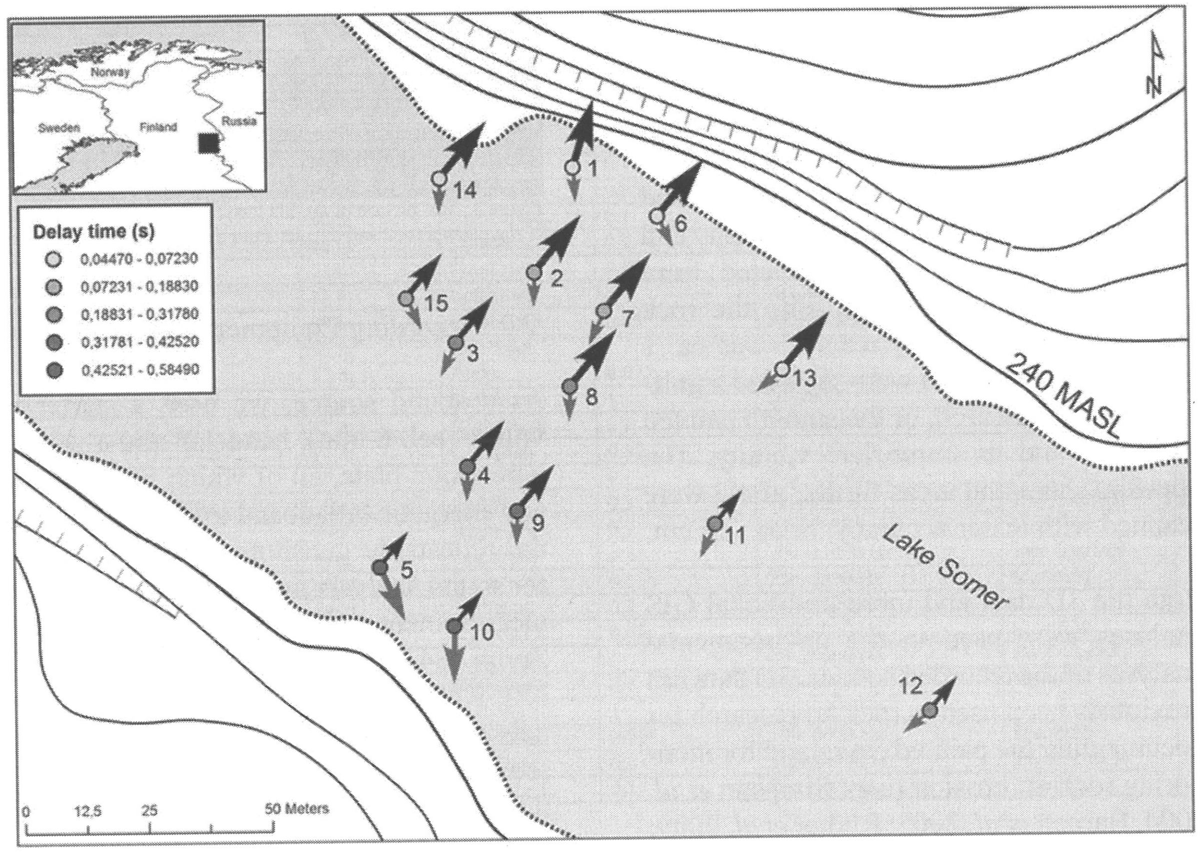

Figure 2. Map of the measurement points and the main results of the recording: direction of the arrow = direction of arrival of the echo, size of the arrow = amplitude of the echo with four scale (0–0.1, 0.11–0.5, 0.51–0.99, > 1), colour of the arrow = structure of the echo (black = two-fourfold, grey = manifold), colour of the measurement point = delay time of the echo coming from the northern shore. Points 1 and 6 are situated closest to the painted rock.

2.1. Mapping

Before recordings, we selected 15 measurement points and marked them with buoys. Points were selected so that 10 of them were located in lines between the rock painting and the opposite shore (Figure 2). In addition, we selected five control points east and west from the painted area. The coordinates of the points were measured using a handheld GPS device. A RTK-GPS (real time kinetic) was also tested in order to acquire more accurate geographic reference points, but the high and steep lakeshore cliffs blocked the signal, making the use of this device impossible. Because of the wind and the deep water in Lake Somer, the buoys moved during the day. The buoys that formed the grid were nevertheless more stable, whereas the location of the control points might have shifted. The painted rock, its environment and the measurement points were also measured using a Leica ScanStation 2 laser scanner. This is a scanner used for surveying infrastructure, topography and buildings. Scanning was conducted from one point on the shore opposite the rock paintings. The accuracy reached was ca. 1 cm at the areas, which were regarded significant for the research, or the smooth painted rock wall and its immediate vicinity. The opposite shore and areas further afield were scanned with lesser accuracy, or ca. 2.5 cm.

Both the 3D data and more traditional GIS analyses were used in the environmental analyses of the recorded sounds. 3D data has previously been used in rock art research for documenting the painted caves and for monitoring rock art erosion (e.g., Simpson *et al.* 2004; Barnett *et al.* 2005; Rüther *et al.* 2009; Lerma *et al.* 2010; Rodríguez-Gonzálvez *et al.* 2012). 3D has enhanced the visualization techniques for recording cave spaces. 3D data and acoustic recordings have, nevertheless, rarely been combined in archaeology. A few examples may be cited, but they mostly describe acoustic phenomena in built spaces (e.g., Both 2009; Paliou & Knight 2013). Here 3D data is mainly used to describe the relationship between the echoes and topographical features, e.g. the distance of the measurement points from the shore and the form of the painted rock. Our 3D model also visualizes the topographic features of Lake Somer, showing that the paintings were made on a part of the cliff that differs from its surroundings by its smoothness and inclined form (Figure 3). The combination of 3D data and acoustic measurements helps to explain some variabilities in the acoustic data.

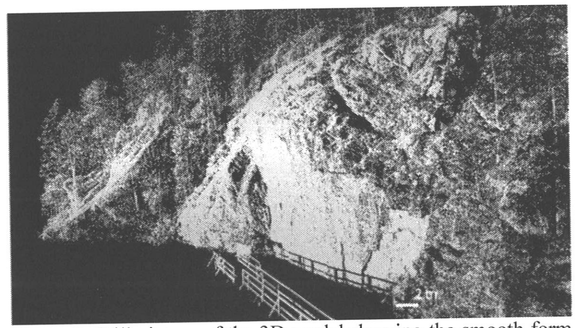
Figure 3. Still picture of the 3D model showing the smooth form of the painted rock and the pier from the southeast.

2.2. Recording Equipment and Techniques

As a sound source, we used a starter revolver (cal. 6 mm), handclap and a wooden percussion plate, all of which produce brief and energetic broadband impulses. Of these, the repeatable gunshots were mainly used for sound analysis. Impulse responses of the measurement points were recorded with a Zoom H4n portable recorder (48 kHz/16 bit), which allows recording on four channels simultaneously, using the built-in stereo microphone and two external inputs, in this case Neumann KM 183 condenser microphones. The A weighted sound pressure level of ambient sounds was measured with an Amprobe SM-20 sound level meter.

Neumann KM 183 is a diffuse field pressure microphone providing a flat frequency response at a 90° angle from the diaphragm. In our recordings, the KM 183s were used as an AB stereo pair pointed upwards with a mutual distance of 22 cm, i.e. roughly equal of typical ear-to-ear distance of a human head. The AB stereo pair allows measuring the angle of arrival of the reflected impulses based on the time difference of the respective impulses in the recorded microphone signals. The H4n internal XY stereo microphone signal served two functions: 1) a secondary independent stereo recording, where the stereo image is formed by interchannel intensity difference, and 2) a reference signal to separate reflections arriving from the front of the microphone array from those arriving from the back.

The recording equipment was placed at one end of the boat, while the gunner and player sat at the other end of the boat. The distance between these two was 3 m. Although we tried to direct the front, XY microphone precisely 120° towards southeast, this proved to be difficult. The boat was gliding and turning during the recording due to the currents of the lake. For this reason, the results of the directional analysis must be rounded off.

M-point	Time delay	Distance	Direction	Amplitude	Frequency range	Structure
1	0.0447 s	8 m	Left	1	20–20000 Hz	Two-fourfold
1	0.5728 s	98 m	Right/front	0.05	250–3500 Hz	Manifold
2	0.1799 s	31 m	Left/front	1	20–20000 Hz	Two-fourfold
2	0.4412 s	75 m	Right/front	0.1	300–3500 Hz	Manifold
3	0.2738 s	47 m	Left/front	0.7	20–13000 Hz	Two-fourfold
3	0.3467 s	59 m	Right	0.1	250–3500 Hz	Manifold
4	0.4252 s	73 m	Left/front	0.55	20–9000 Hz	Two-fourfold
4	0.1885 s	32 m	Right/front	0.1	250–3500 Hz	Manifold
5	0.5792 s	99 m	Left/front	0.3	20–6000 Hz	Two-fourfold
5	0.0386 s	7 m	Front/right	0.95	20–20000 Hz	Manifold
6	0.0666 s	11 m	Left/front	1	20–20000 Hz	Two-fourfold
6	0.5775 s	99 m	Front/right	0.05	200–3500 Hz	Manifold
7	0.1883 s	32 m	Left/front	1	20–20000 Hz	Two-fourfold
7	0.4495 s	77 m	Right	0.075	300–3500 Hz	Manifold
8	0.2946 s	50 m	Left/front	1	20–20000 Hz	Two-fourfold
8	0.3341 s	57 m	Right/front	0.1	300–3500 Hz	Manifold
9	0.4175 s	71 m	Left/front	0.55	20–11000 Hz	Two-fourfold
9	0.2160 s	37 m	Right/front	0.1	200–12000 Hz	Manifold
10	0.5849 s	100 m	Left/front	0.3	20–8000 Hz	Two-fourfold
10	0.0429 s	7 m	Right/front	0.7	20–20000 Hz	Manifold
11	0.2732 s	47m	Left/front	0.2	200–11000 Hz	Two-fourfold
11	0.3532 s	60 m	Right	0.1	250–3500 Hz	Manifold
12	0.3178 s	54 m	Left/front	0.2	100–9000 Hz	?
12	0.3757 s	64 m	Right/back	0.05	200–4000 Hz	Manifold
13	0.0723 s	12 m	Left/front	1	20–20000 Hz	Two-fourfold
13	0.4446 s	76 m	Right/back	0.1	250–6000 Hz	Manifold
14	0.0517 s	9 m	Left/front	1	20–20000 Hz	Two-fourfold
14	0.4592 s	79 m	Right/front	0.075	200–6000 Hz	Manifold
15	0.1246 s	21 m	Left/front	0.6	100–14000 Hz	Two-fourfold
15	0.3947 s	67 m	Front/right	0.1	250–5000 Hz	Manifold

Table 1. Characteristics of the main echoes at different measurement points: measurement point, time delay of the echo, distance from the measurement point to the reflecting surface, direction of arrival of the echo with 12 scale (front, front/right, right/front, right, right/back, back/right, back, back/left, left/back, left, left/front, front/left [front = 120° towards southeast]), amplitude of the echo, frequency range of the echo, structure of the echo i.e. rough number of the reflections with two scale (two-fourfold, manifold).

2.3. Sound Analysis

The recorded sound files were analyzed with the Spectutils sound analysis and visualization software toolkit (Lassfolk & Uimonen 2008). Based on the GNU Octave numerical computation language, Spectutils provides functions for creating oscillograms and Short-Time Fourier Transform based spectrograms and sonograms. The onsets of the reflected impulses were located visually from the Spectutils oscillograms. The approximate angle of arrival of the reflected impulse can be calculated from the arrival time difference between the AB stereo microphone pair with the following formula:

$$\theta = \cos^{-1}\left(\frac{\Delta t_{AB}}{\Delta t_{MAX}}\right),$$

where Δt_{AB} is the measured interchannel time difference and Δt_{MAX} is the maximum time difference. The result ranges from 0° to 180°, from an extreme right to extreme left angle, respectively. Δt_{MAX} can be either measured with a reference impulse fired on location from a 0° angle of the microphones or calculated as follows:

$$\Delta t_{MAX} = \frac{d(A,B)}{c}$$

There, $d(A,B)$ is the mutual distance (in cm) of the microphone capsules A and B, and c is the speed of sound (in cm/s). Reflections arriving from backside of the AB microphone pair can be calculated with the same formula by reversing the channels and adding 180° to the resulting angle. Furthermore, an approximate distance from a measurement point to a reflective surface can be calculated with the formula T / 2 x 342 m/s, where T is the time delay of the echo, and 342 m/s is the speed of sound at a temperature of +17–18 C.

3. Results

Echoes, i.e. reflections and repetitions of the initial impulse, were heard with the ear at all measurement points (Table 1, Figure 2). Gunshots, handclap and clanging of the percussion plate all performed well. For the most part, the echoes appeared to be reflecting from both shores of Lake Somer, which in this place is about 110 m in breadth. The strongest and most distinct echoes were heard at measurement points 1–10, more or less at right angles to the massive, smooth, vertical painted rock. By ear, it was evident that these reflections were arriving from the direction of the painted rock, and from the more gently sloping shore opposite to it.

3.1. Echo from the Painted Rock

The echo arriving from the painted rock is clearly visible in the oscillograms of measurement points 2–5 and 7–10, some distance away from the rock wall (Figure 4, 5). The spike representing the echo is tall and short indicating that the sound is loud and more or less similar to the initial gunshot. The two-piece form of the spike, however, indicates that the sound is reflected a couple of times. The first of these peaks – or an even fainter one before it – could be caused by the pier in front of the wall. In the sonograms, it can be seen that the echo contains all frequencies of the gunshot (20–20 000 Hz) (Figure 6), or at least a broad range of these, even from a distance of one hundred metres. The highest frequencies are attenuated at measurement points 4, 5, 9 and 10, probably due to the air absorption, windshields of the microphones and the minor high frequency content of the gunshot. Near the rock wall, at measurement points 1 and 6, the echo coincides with the gunshot and therefore cannot be perceived as a separate sound.

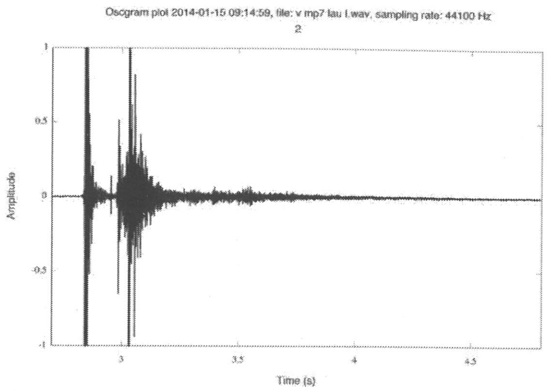

Figure 4. Oscillogram showing the impulse response at measurement point 7. From left: the starter revolver shot, the echo from the painted rock, the echo from the opposite shore.

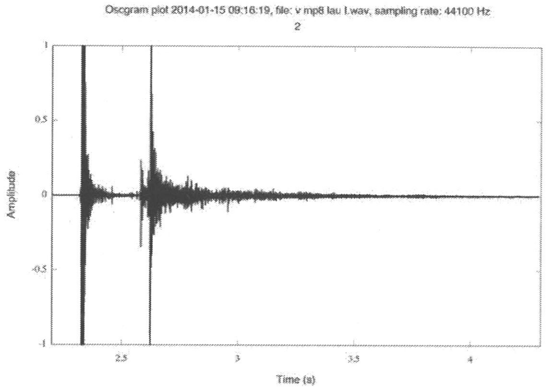

Figure 5. Oscillogram showing the impulse response at measurement point 8. From left: the starter revolver shot, the echo from the painted rock, the echo from the opposite shore.

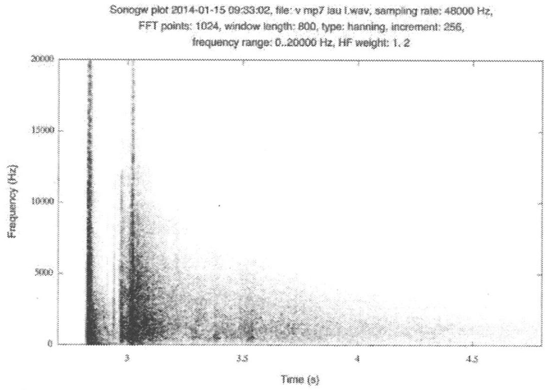

Figure 6. Sonogram showing the impulse response at measurement point 7. From left: the starter revolver shot, the echo from the painted rock, the echo from the opposite shore.

The time delay of this echo varies with the measurement point, and corresponds roughly to the distance from that particular point to the painted rock. At measurement point 2, for example, the time delay is 0.180 seconds, which means that the reflecting surface must be at a distance of 31 m, i.e. somewhere near the painted rock. Also small time differences between the microphones confirm that the sound arrives from this direction. Slight deviations at measurement points 6–10 could be explained by the uncontrolled turning and gliding of the boat. Such a strong response from the painted rock is not surprising. A smooth, hard, vertical rock wall is generally highly reflective, and tends to reflect nearly all impinging sound energy (Waller *et al*. 1999, 180–182). A large area of the inclined wall, in this case about 130 m^2, ensures that a vast amount of energy is reflected back to the sender.

3.2. Echo from the Opposite Shore

The echo arriving from the opposite shore is best seen in the oscillograms of measurement points 1 and 6, where the echo from the painted rock is not blanketing out other reflections (Figure 7). Contrary to the previous echo, this echo is soft and long, and seems to convert the gunshot into a series of slight, rapidly spaced echoes, not resolvable by the human ear. In the sonograms, it can be seen that the sound contains mainly mid-frequencies 250–3 500 Hz (Figure 8). Higher and lower frequencies are quickly attenuated along the way. At measurement points 4, 5, 9 and 10, this echo precedes, and at measurement points 1, 2, 6 and 7, it succeeds the echo from the painted rock (Figure 9). Thus, two different echoes can be heard answering each other and reversing the order.

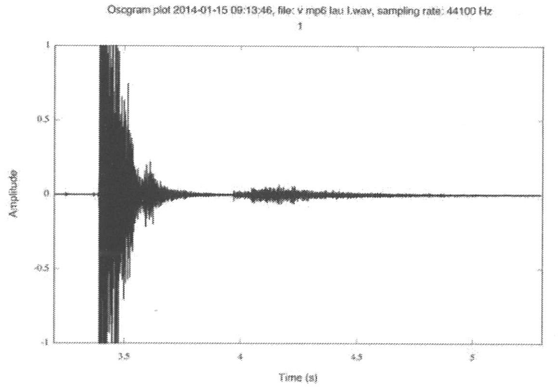

Figure 7. Oscillogram showing the impulse response at measurement point 6. From left: the starter revolver shot, the reflection from the painted rock, the echo from the opposite shore.

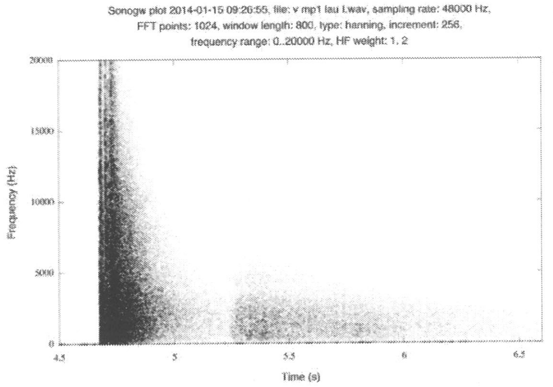

Figure 8. Sonogram showing the impulse response at measurement point 1. From left: the starter revolver shot, the reflection from the painted rock, the echo from the opposite shore.

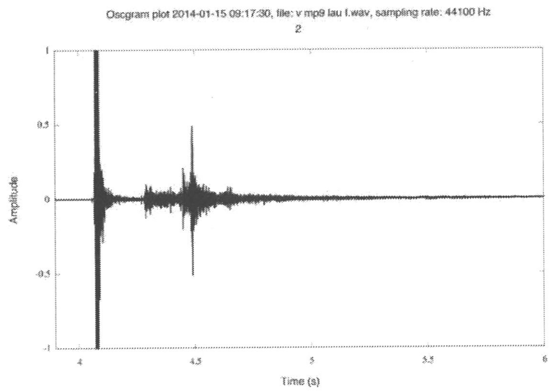

Figure 9. Oscillogram showing the impulse response at measurement point 9. From left: the starter revolver shot, the echo from the opposite shore, the echo from the painted rock.

The time delay of this echo varies with the measurement point, and corresponds roughly to the distance from that particular point to the opposite shore. At measurement point 2, for example, the time delay is 0.441 seconds, which means that the reflecting surface must be at a distance of 75 m, i.e. somewhere near the opposite shore. Also small time differences between the microphones confirm that the sound arrives from this direction. As there are no bare cliffs to be seen on the shore, it is possible that the sound reflects back from tree trunks in the shoreline. Multiple overlapping and slightly divergent reflections within the first 0.2 seconds of the echo support this hypothesis. According to Shelley *et al.* (2013), narrow tree trunks tend to reflect especially midfrequencies around the 1000 Hz octave band, where the wave length is comparable to the diameter of the trees.

3.3 Flutter Echo Between the Painted Rock and the Opposite Shore?

When the long tail of the latter echo is studied more carefully, it appears that it has intensity peaks at more or less frequent and sparse intervals. At measurement point 8, for example, these peaks occur 0.630 and 0.935 seconds after the impulse. At measurement point 6, they occur 0.654 and 0.718 seconds after the impulse. At measurement point 7, the loudest frequency of the percussion plate makes audible peaks 0.556, 0.643 and 0.862 seconds after the impulse. These level boosts suggest re-reflection and superposition of two waves traveling in opposite directions (cf. Rossing *et al.* 2002, 44–46). The pattern hints that, at least at measurement points 1–10, sound not only reflects back from the painted rock and the opposite shore, but also bounces back and forth repeatedly following the same path. As these later, attenuated returns occur in fairly rapid succession, they cannot be heard as distinct echoes, but as a continuation or undulation of the earlier sound. Thus, the painted rock seems to be an efficient sound reflector, capable of producing both a strong true echo and this kind of multiple flutter echo.

3.4. Other Echoes and Ambient Sounds

At other measurement points 11–15, echoes arrive similarly from both opposing shores of the lake. These echoes, however, are less distinct and more rapidly attenuated, probably because there are no smooth rock walls in the shoreline (Figure 10). The painted rock still dominates the scene, but it is unresponsive – at least ostensibly – because the measurement points are at steep angles to it. The characteristic two-piece echo of the rock is also missing from the plots. At measurement point 15, four or five successive echoes can be heard answering from different directions. At measurement point 12, brawl of water begins to be heard, rising the ambient noise level (LA) from 29–30 dB upwards. The brawl originates from small rapids at the eastern end of the lake, some 250 m away. By the rapids, the noise level (LA) is 60–62 dB and prevents any echoes from being perceived. At the studied site, no traffic noise or any other urban sounds can be heard.

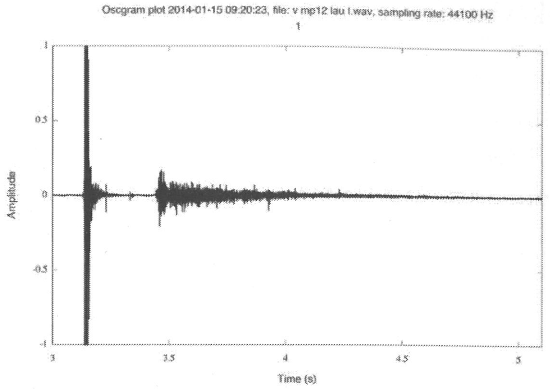

Figure 10. Oscillogram showing the impulse response at measurement point 12. From left: the starter revolver shot, the echoes from both shores of Lake Somer.

4. Discussion

The topographic setting of Finnish rock painting generally follows a set of guidelines, where visually prominent, smooth, light or shiny overhangs facing south have been favoured (Lahelma 2008, 20–22), but every once in a while a seemingly 'perfect' cliff bears no trace of painting, while a more modest-looking one adjacent to it has many figures (Kivikäs 1995, 16–30). Clearly, something is missing from the picture, and that something may well be the capacity of the cliff to reflect sound waves, associated by many traditional cultures with the presence of spirits (Waller 2006). As noted in the introduction, the sound dimension of Finnish rock art has been acknowledged before, but our work represents the first attempt to develop methodology for measuring and analysing the echoes reflected from a rock painting. While still preliminary, it may help to explain why some cliffs were perceived as sacred while other, outwardly similar cliffs evidently were not.

4.1. Efficient Sound Reflection

Our first recordings at the rock painting of Värikallio indicate that the massive smooth painted rock is an efficient sound reflector. It reproduces the impulse rather accurately, in respect of intensity, structure, duration and spectrum of the sound, even from afar, the other side of the lake. It also seems to reinforce and prolong the echo from the opposite shore by creating a repetitive flutter echo between the parallel shorelines. The echoes from the painted rock are not the only echoes at the studied site, but they dominate the space. Even a soft conversation and laughter appear to be reflecting back to the sender. Further studies with various softer impulses, sine sweeps and more stationary measurement points would be needed. At any rate, this kind of rock wall is probably the most efficient sound reflector found in the nature, or known by the people in prehistoric Finland.

Echoes and flutter echoes are undesirable phenomena in current architectural acoustics (Rossing *et al.* 2002, 534–537). Reflected waves of the echo appear to be originating from a point behind the barrier, from inside the wall, or outside the enclosed space (Rossing *et al.* 2002, 51–52). Reflected waves behave ambiguously, disorientate the listener and give rise to auditory illusions (Cross & Watson 2006, 111–113). Although avoided today, these effects could be viewed positively in pre-modern times, and exploited in the use of certain archaeological spaces, for example rock art sites that have been associated with shamanistic rituals (Lahelma 2008). However, it is important to notice that the properties of smoothness, hardness and verticality, not only contributed to sound reflection, but also provided good canvases to painters.

4.2. Drumming Figure in the Painting

Some ethnographic sources indicate that

Sámi *noaidi* or shamans of the historical period sang or chanted at places that featured a prominent echo (Paulaharju 1932, 50), and while drumming is not mentioned, it seems reasonable to assume that a shaman drum (*goabdes*) could also be used in such a context, as shamanism and the use of drums are strongly connected in both Sámi culture and more generally in the circumpolar Arctic (e.g., Ahlbäck & Bergman 1991). This makes it particularly interesting to note that in the course of our fieldwork, we identified a probable depiction of a drummer (Figure 11) overlooked in the previous documentation work carried out at Värikallio (Taavitsainen 1979; Kivikäs 1995, 87–101). The figure (height 22 cm, width 17 cm) is located at the right end of the panel (part of Taavitsainen's group *k*), ca. 1.40 m above lake surface, and appears to hold a round object in its left hand, while the right hand is raised in a striking or beating position. It is unique in Finnish rock paintings, where human figures generally do not carry objects or engage in any kind of activity, but has parallels in the hunter-gatherer rock carvings of Northern Norway – such as Skavberg (Simonsen 1958) and particularly Alta (Helskog 1988, 53, 94) – where drumming figures exhibit a very similar posture. If our identification of the Värikallio figure is correct, this provides a strong argument in support of the significance of sound rituals at rock paintings. The effects of drumming on the site acoustics would be worth testing.

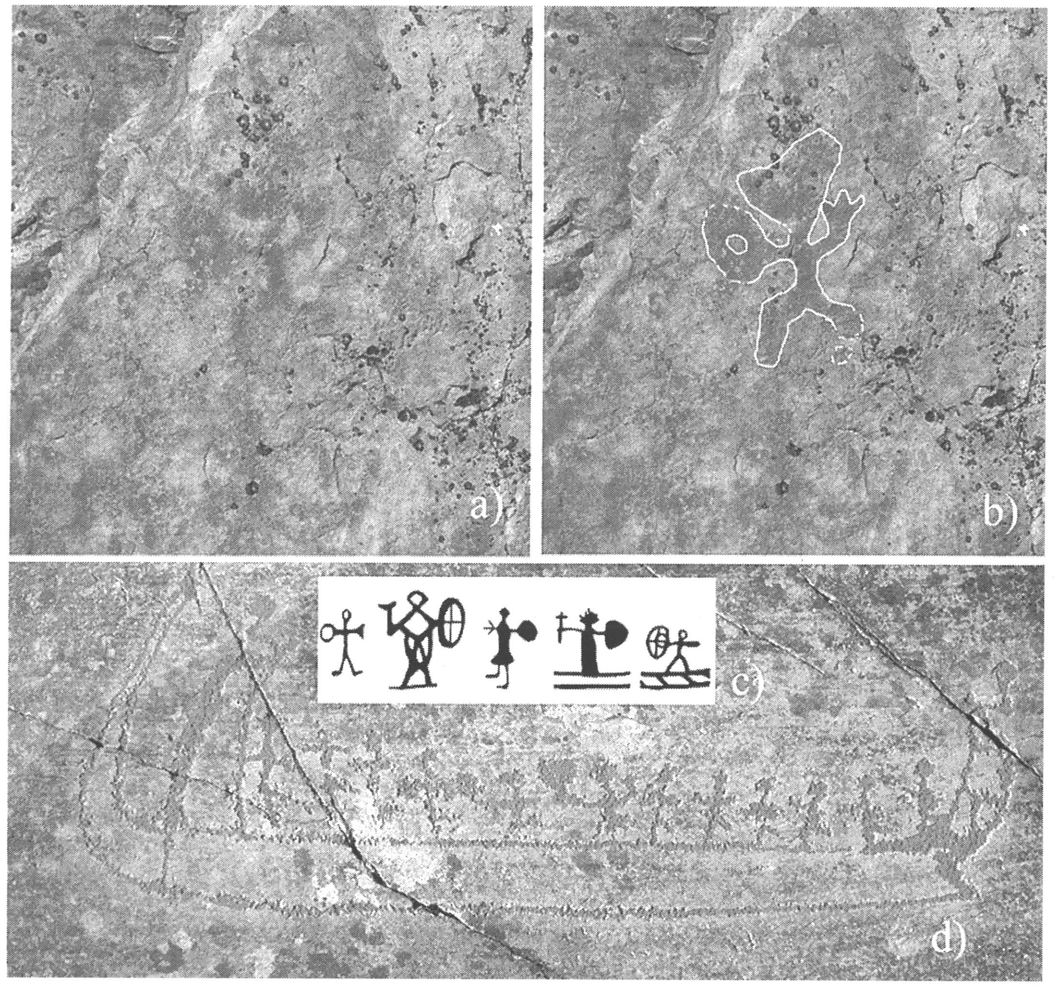

Figure 11. A probable representation of an anthropomorph beating a drum at Värikallio: a) an unmodified photo of the figure, b) the saturation of red hues has been modified and a tentative outline marked with white, c) representations of shamans carrying drums from the membranes of various Sámi shaman drums (from Manker 1950), and d) a ceremonial boat figure from Alta (Northern Norway) with 14 occupants, two of them apparently beating drums. Photos a-b & d by Antti Lahelma.

5. Conclusions

According to our field recordings, the surroundings of the rock painting of Värikallio is clearly resounding, having audible echoes at each measurement point. The most remarkable and carrying echo is answering from the direction of the painted rock, the largest rock wall in this part of the lake. The painted rock appears to be highly responsive, and to create not only a strong true echo, but also a flutter echo between the opposite shore and itself. These results, as well as an identified drumming figure among the paintings, lend support to the hypothesis that sound played an important role in the development and use of this and other Finnish rock art sites.

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The Pharos of Alexandria As a Total Work of Art and a Soundscape

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ABSTRACT: In this paper we are going to exam the Pharos as a Total Work of Art, connected with the soundscape and landscape of Alexandria. Viewing the Pharos through the prism of the contemporary history of art and music, we analyze the characteristics that render it a masterpiece. As a soundscape the Pharos is connected to the environment and the perception of the people who lived in the area in a refined era. In this sense this artwork connects ancient and contemporary thought as well as Oriental and European sensory flair.

KEYWORDS: Soundscape, Total Work of Art, Hellenistic Alexandria, Pharos, Tritons, Blackbird, Ancient Greek and Roman Technology.

The Site

The Lighthouse (The Pharos) of Alexandria, one of the seven wonders of the Ancient World, marked the entrance to the city port of Alexandria. The Pharos was constructed in the early 3rd century BC, at the time when the Ptolemaic dynasty had reached the zenith of its power and was soon to become the landmark of Alexandria[1] .

Even before the astounding construction there was, of course, the legendary site, that was sung by Homer as the home of the ever-changing god Proteus. Alexander the Great, who used to sleep with the Odyssey and the Iliad under his pillow, was eager to build an eponymous and unmistakably Greek city on the Nile Delta. The architect had already taken the necessary measurements when the young king dreamt of an old grey-haired man that pointed out the island of Pharos to him. Alexander exclaimed that Homer was, besides other things, the greatest architect and he immediately gave orders to lay down the plan for the lighthouse on this spot (Plut. Al. 26.5-8).

The site was indeed favorable in the sense that the island lay, far enough off the coast of the Canobic mouth of the Nile Delta to

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Abbreviations
FD: Fouilles de Delphes (1909-2010).
IG: Inscriptiones Graecae (1873-2013).
PP: W. PEREMANS, E. VAN'T DACK, Prosopographia Ptolemaica I-IX, Studia hellenistica (1952-1981).
ThesCRA: Thesaurus Cultus et Rituum Antiquorum I-VIII (2004-2012)

[1] A. BERNARD, Alexandrie la Grande (1966), p. 110-111; P. CLAYTON – M. PRICE, *Τα επτά θαύματα του αρχαίου κόσμου* (greek transl. 1994), p. 188; P. VITTI, “Η αρχιτεκτονική του φάρου της Αλεξάνδρειας”, in S. DROUGOU (ed), *Κερμάτια Φιλίας. Τιμητικός Τόμος για τον Ιωάννη Τουράτσογλου,* (Athens 2009), p. 302-303. This was first supposed by M. van Berchem in the 19th century.