

ARCHAEOACOUSTICS: A KEY ROLE OF ECHOES AT UTAH ROCK ART SITES

Archaeoacoustics is an emerging field of study investigating sound in relation to the past. The intent of this paper is to convey appreciation for the echoes at Utah rock art sites, by recognizing the importance of their influence both on the ancient artists, and on modern scientific studies. The title of this paper is thus intentionally worded such that it could be understood in two different but interrelated ways. One, the study of sound indicates that echoes were an important factor relative to rock art in Utah. Two, the echoes found to be associated with Utah rock art sites have been particularly helpful in developing theories relating sound to past cultural activities and ideologies. This paper describes in a roughly chronological order the events and studies that have led to Utah featuring prominently in the development of archaeoacoustics.

More than three dozen rock art sites in Utah, as well as hundreds of others around the world, have been documented as possessing remarkable echoes or other acoustic phenomena. The first systematic analysis of a rock art site for the localization of sound reflection consisted of acoustic data collected throughout Horseshoe Canyon. The results showed that the five art sites correlate exactly with the five locations within the canyon possessing the strongest echoing. The cultural significance of this is that many ancient cultures are known to have had supernatural explanations for echoes, as they are described in echo myths from around the world. It is theorized that echoing locations such as caves and canyons were considered sacred, and were decorated with images evoked upon hearing the echoes. For example, echoes of percussion noises such as clapping can mimic the sound of hoof beats, and hooved animals are a frequent rock art theme. Voices appear to

emanate from rock surfaces where beings are depicted, as if the images are speaking. Myths attribute echoes to sheep, humans, lizards, snakes and other figures that are major rock art themes. Echo-rich Fremont Indian State Park even has a panel that has been interpreted as showing the mythological Echo Twin. The study, appreciation, and preservation of rock art acoustics in Utah are encouraged.

INITIAL STUDIES OUTSIDE UTAH

A conceptual connection between sound and rock art originally occurred to me when visiting European Palaeolithic caves in 1987. A fortuitous shout at the mouth of a cave resulted in a startling echo. I immediately remembered the Greek myth in which echoes were attributed to the answering calls of a nymph turned to stone (Ovid). This belief in a conscious supernatural being who is responsible for natural phenomena is a form of animism. I theorized that echoes attributed to spirits would have been a powerful motivational factor for the production of rock art in sound reflecting places such as caves and canyons (Waller 1993a).

At about the same period in time, several other researchers noticed sound in relation to rock art (Hedges 1993, Reznikoff and Dauvois 1988, Steinbring 1992).

Thus began my investigations of sound and rock art. At first, I simply noted the echoes I heard. Progressing from subjective descriptions of echoes to objective measurements, I later made recordings at a number of caves and open air sites in France. These recorded echoes were analyzed with a sound level meter. The resulting data served to objectively document the

presence of strong sound reflections at rock art sites (Waller 1993b).

I also tested a variety of rock art sites in Queensland, Australia and found echoes associated with the art there, too (Waller 2005).

ACOUSTIC RESULTS IN UTAH

Three Kings

To analyze recordings of sound reflections more efficiently and in more detail than in the studies I had conducted in France, I purchased a computer program that displays sounds graphically as a function of time. The first rock art site that I analyzed with this new program was the Three Kings panel near Vernal, in northeastern Utah. Like the other petroglyph panels elsewhere at Dry Fork Creek, I found excellent sound reflection. The Three Kings panel is located very high up on a cliff. What I found was that the echo appears to emanate from the exact spot high on the cliff face where the artists chose to decorate. For the documentation process of the echo, I recorded the ambient background sound, then made a percussion sound similar to clapping, using a spring-loaded device that gives reproducible results. The primary sound, as well as any reflected sounds occurring afterwards, were captured on tape for later analysis. These recordings were digitized on a Macintosh personal computer using a commercially available program called SoundEdit Pro (version 1.0). The results are shown in Figure 1, clearly showing the existence of an echo. The reflected sound is 30 dB above background, and is separated from the primary sound by 0.1 sec, a delay which is distinguishable by the human ear. These results were presented at the International Rock Art Congress held in Flagstaff in May of 1994 (Waller, in press).

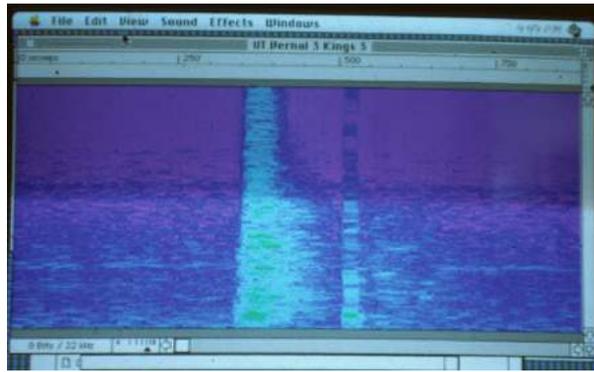


Figure 1. Echogram of sound at Three Kings near Vernal, Utah. Frequency is on the Y-axis, time in seconds is on the X-axis, and sound pressure (loudness) is indicated by a color scale. An impulse made at time = 0 seconds is followed by reflected sound (echoing) at greater than 0.1 seconds.

Horseshoe Canyon Systematic Study

In conjunction with the IRAC'94 congress, I participated in a four-day rock art tour of the Colorado Plateau. This tour included many wonderful rock art sites, but the main reason I wanted to go was to see "The Holy Ghost" (Figure 2). This captivating image is part of the Great Gallery, found in Horseshoe Canyon (formerly called Barrier Canyon), located in Utah's Canyonlands National Park. The Great Gallery is considered one of the premier rock art sites in the world, and represents a major category of rock art called the Barrier Canyon



Style. These images painted in reddish brown are estimated to be thousands of years old.

Figure 2. Detail of the Holy Ghost figure from the Great Gallery in Horseshoe Canyon, Utah.

The art is characterized by enigmatic, ghostly looking anthropomorphic (human-shaped) and zoomorphic (animal-shaped) figures (Figure 3).



Figure 3. Barrier Canyon Style anthropomorphs and zoomorphs from the Shelter panel in Horseshoe Canyon, Utah.

Hiking into the canyon, our group came first to a cluster of figures painted high up on the canyon wall, called appropriately enough the High Gallery. I could distinctly hear the voice of a tour guide bounce from high off the wall exactly where the art occurs, as if the painted beings themselves were speaking. Next we came to a group of paintings called the Shelter site, and further along, a huge cave called the Alcove site with more paintings. Visually, there appeared to be no obvious reason any of these sites would have been selected for decoration, as there are plenty of similar rock surfaces suitable for decoration all along the canyon. My sense of hearing, however, revealed that each of these art sites occurs at places with exceptionally clear echoes, in striking contrast to the undecorated portions of the canyon.

Although the group stopped to rest and eat in the shade of the Alcove, I could not wait to see the magnificent Great Gallery. I pressed on alone in my pilgrimage through the canyon, until finally the moment I had been anticipating arrived, and I stood face to face with the Holy Ghost. It was an awesome sight, seeing this ethereal being surrounded by many other ghostly figures. Unfortunately, a whole class of art students was there, and it was taking an incredibly long time for their teacher to basically say we know hardly anything about this art. Impa-

tient to listen for acoustical effects, I walked around and discretely made some clapping noises. This drew a few curious stares, but the echoes were worth it. Eventually the class packed up and left. Just when their conversation started to die down and I thought I could start some recording, my own group arrived and began chattering excitedly at the sight of all the rock art. Sighing, I sat down and ate my lunch while contemplating the Holy Ghost. Then I joined in with the others snapping photos left and right. I gave a demonstration of the acoustics to the group, showing that the Holy Ghost will speak back to you if you address him from about twenty yards away.

When the group finally left down canyon for the return hike, with the permission of the group leader, I actually continued further up the canyon. I had spontaneously decided this would be an ideal location to systematically test the acoustics all along the canyon. My aim was to objectively verify the impression I gained on the way in: that the art is located at the places with the best echoes. Beginning at a point well beyond the Great Gallery and out of sight of art, I made the return hike while making recordings at regular intervals. That was quite a hike, and one I am sure I will never forget: miles of rugged trail under the hot Utah sun in June, and since I was stopping so often (eighty times total) to set up my equipment, take measurements, then pack up the equipment, I jogged in between each stop so that I would not keep the group waiting too long for me at the end. As a result, I had to hold my panting breath for each measurement (done in triplicate at each stop) to avoid interfering with the recording!

Even with my computer program, it took me over two years to complete the analysis of all the data (my baby daughter Julia arrived in the meantime). The results of these quantitative measurements, depicted in Figure 4, show that all four rock art clusters in Horseshoe Canyon are situated exactly at locations with echoes louder than the surrounding non-decorated por-

tions of the canyon. Furthermore, while testing in the canyon I had noticed an additional location with good echoing near a bend in the canyon about half-way between the Alcove and the

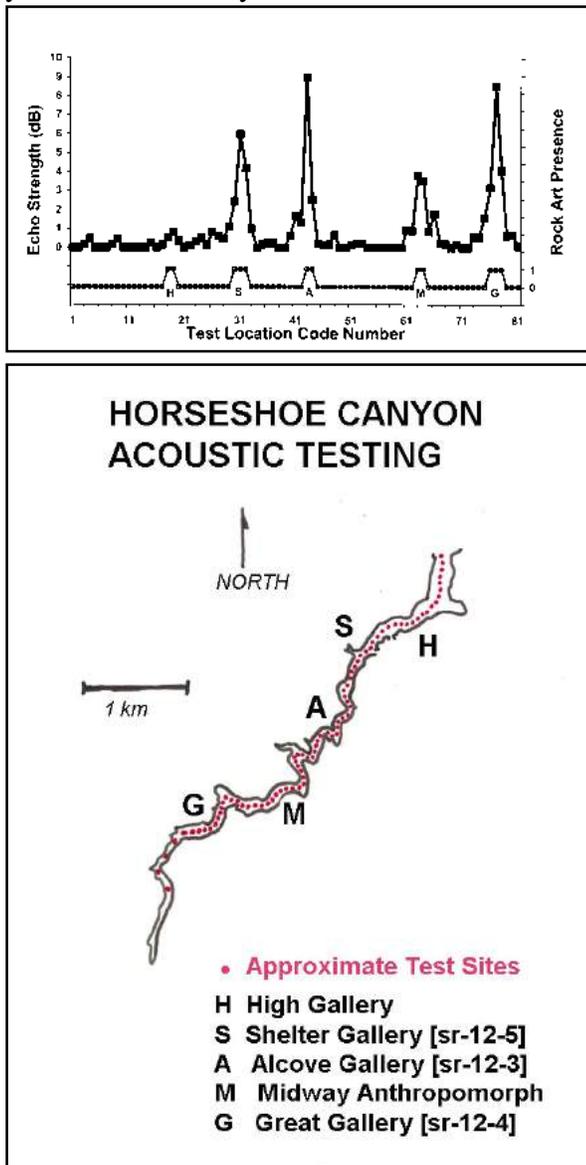


Figure 4. Measurements of sound reflection throughout Horseshoe Canyon, Utah. Sound pressure (loudness) of the echoing is shown on the Y-axis, and test location number as an indication of position is shown on the X-axis along with abbreviations for the rock art panels at certain of the test locations: H = High, S = Shelter, A = Alcove, M = mid-way anthropomorph, and G = Great Gallery.

Great Gallery, and this stands out distinctly in the graphics of the results (designated as test location #63 in Figure 4). I called the Canyonlands National Park Archeologist who had

accompanied our group to ask whether any traces of art had been found anywhere else in the canyon besides the four major clusters.

Indeed, she replied that “there is a single small anthropomorphic [human-shaped] figure painted near a bend about midway between the Alcove and the Great Gallery” (Nancy Coulam, personal communication 1996). I immediately faxed her my graph showing the presence of a strong echo where she had described. This exciting and dramatic example of anticipating the presence of art at a location with strong echoing relative to its surroundings (together with the many examples of anticipating echoes at art locations) demonstrates that the theory of acoustic motivation for rock art has predictive ability, one of the hallmarks of a valid theory. Thus the five rock art sites within Horseshoe Canyon -- the High panel, the Shelter, the Alcove, the mid-way anthropomorph, and the Great Gallery -- all have the strongest echoes within the canyon. A statistical analysis of the data showed that out of eighty tests the probability of the five art sites occurring by random chance at the locations with the strongest echoes is less than one in ten thousand (Waller 2000).

Acoustics At Other Utah Rock Art Sites

I have visited and tested a variety of other rock art sites in Utah, and found echoes at each one of them:

Fremont Indian State Park -- echoes from cliffs and canyons.

Willow Springs -- echoes from large boulders.

Butler Wash: Wolf Man/Yucca and Procession panels -- echo from each cliff face.

Sand Island -- echo from cliff.

River House ruins -- echo from shelter in cliff.

San Juan River: Kachina panels -- echo from cliff.

Hog Springs -- echo and reverberation in large cave.

Capitol Reef -- echo from cliff.

Wire Pass -- echo from cliff.

Zion southgate -- echo from cliff and facing slope

Clamshell -- echo from cave and facing rocks.

In addition, a number of people have informed me, via personal communications over the years, of acoustical phenomena at other Utah rock art sites:

Hell Roaring or Hey Joe Canyon (William Biesele);

Sego Canyon (William Biesele);

"Black Dragon" site (Dana J. von Kraut);

Newspaper Rock near Moab (Dana J. von Kraut);

Courthouse Mesa (Dana J. von Kraut);

Wild Horse Canyon (Pam Baker);

Mouth of McDonald Creek (Pam Baker);

Turkey Pen Ruin, Split Level Ruin and Perfect Kiva in Grand Gulch Primitive Area (Susan Villalobos-Boehm);

Titus Creek (Jesse Warner);

Nine-Mile Canyon (Layne Miller);

Bird Site in Canyonlands (Larry Larason)

Head of Sinbad and Temple Mountain Wash (Cathleen McGowan);

Five Faces (Margaret Berrier);

Indian Canyon (Margaret Berrier);

Kane Creek (Margaret Berrier);

Wild Horse Canyon (Margaret Berrier);

Three Fingers (Margaret Berrier);

Rochester Creek (Margaret Berrier);

Pleasant Creek (W. Tapp, H. Mulder) Southfork Indian Canyon (L. Koss).

Music Temple in Glen Canyon [now flooded] (Joan M. Bennett)

Rock art researchers are encouraged to clap or call out upon approaching rock art sites, and also while standing at rock art sites, and listen to determine if the echoing is better there than in the surrounding terrain that does not include rock art. (Please contact me at wallersj@yahoo.com with results.)

ILLUSION OF DEPTH

The following observation captures perfectly the perception of depth that can occur as the result of an auditory illusion. "I first noticed the acoustics of rock art when I heard a car 'drive' out of the Buckhorn panel" (William Biesele, personal communication 1997). Echoes seem to originate from behind sound-reflecting rock surfaces, in a manner analogous to images reflected in a mirror (Waller 2001). In my view, spirits making the sounds were probably thought to dwell within those rocks. Consequently, the rock surface would have been a permeable boundary between the spirits and the listener. Studies of indigenous people in South Africa describe the belief in the spirit world within the rock and its relevance to rock art images that decorate the rock surface. Evidence is shown by Lewis-Williams and Dowson, that San people's rock art relates to the belief in a spirit world beyond the "veil" of the rock surface. The rock art incorporates examples of painted images emerging from cracks or holes within the rocks. (Lewis-Williams and Dowson 1990).

In North America myths have been recorded that describe the belief in a spirit world within the rock, and which feature sound as an important aspect: a magical rock wall appearing like a transparent window when viewed from within as if the rock paintings hung in the air; sounds of voices heard around these paintings; and spirit beings inside the rock producing many sounds such as heartbeat drumming and songs echoing across the lake (Conway 1993:149-157). The experience of depth due to auditory illusion can be experienced at many of Utah's echoing rock art sites.

ECHO MYTHS OF UTAH & VICINITY

The following are short synopses of several echo myths from tribes living in or near Utah. Like the Greek myth about the nymph Echo, these myths explain sound reflection as spirit voices (Waller 1999).

Origin of the Echo [Ute, Paiute]

Teugai (a witch) came near a village one night and called to a little girl, "Bring me my child." The girl thought it was her mother, so she obeyed. *Teugai* had a basket on her back, and she put both the baby and the girl in it and carried them away, scampering through the woods. When the mother missed her children, there was a great search through the village for them. The people all believed that a *Teugai* had taken them off.

Early the next morning, they followed the old hag and found her asleep, wearied from her flight. The people quickly rescued the children.

When *Teugai* awoke and found they had taken the children from her, she went to her grandfather *Togoav* (Rattlesnake), taking all her own family with her. She begged him to take care of them, for she feared the people of the village would come to kill them and her also. Not knowing what to do, he swallowed them all. It made him very sick, and he asked them to crawl out again. This the children did, but the old *Teugai* was stuck fast.

Then *Togoav* crawled out of his own skin, leaving *Teugai* in it. She shouted, "Let me out, let me out!"

"Stay where you are; be still!" said *Togoav*.

Still she screamed, "Let me out, let me out!" But *Togoav* refused to help her and went away.

Then *Teugai* wriggled with the skin into a crevice in the rocks and made her home there. When the people of the village came in search of her, she repeated their words in mockery; and though they heard her voice, they could not find her.

Since that time, all *Teugai* live in snakeskins, and the echoes which are heard in the rocks are their spiteful mockings (Powell 1881).

In another version of this story, the witch first hides with the baby in "a skin that had been

stripped from a huge mountain-sheep" (Skinner 1903)

Night Chant: Divinity Echoing Stone [Navajo]

The Navajo Night Chant (*Yeibichai*) includes offering of prayers to the divinity Echoing Stone on the first day of purification (Highwater 1984).

***Palöngawhoya*, the Echo Twin [Hopi]**

Spider Woman then said to the twin on her left, "You are *Palöngawhoya* and you are to help keep this world in order when life is put upon it. This is your duty now: go about all the world and send out sound so that it may be heard throughout all the land. When this is heard you will also be known as 'Echo', for all sound echoes the Creator."

...*Palöngawhoya*, traveling throughout the earth, sounded out his call as he was bidden. All the vibratory centers along the earth's axis from pole to pole resounded to his call; the whole earth trembled; the universe quivered in tune. Thus he made the whole world an instrument of sound, and sound an instrument for carrying messages, resounding praise to the Creator of all (Waters 1963).

TWIN MOTIF INTERPRETATION

Fremont Indian State Park in Utah has a panel that has been interpreted by LaVan Martineau as showing the mythological Spider Woman and her Twins (Patterson-Rudolph 1997:57-58, Plate 16 and Figure 32); see Figure 5. Since the younger Twin is called "Echo" (see myths section above), a depiction of him would be tantamount to depicting an echo.

Interpretations of rock art have been controversial, because it has been pointed out that one cannot scientifically prove specific meanings beyond any doubt. Nevertheless, acoustic testing could serve to help substantiate interpretations that are related to echo mythology. In this



detail of a rock art panel in echo-rich Fremont Indian State Park, redrawn from Patterson-Rudolph (1997, Figure 32). As interpreted by LaVan Martineau, the Twins are the two circles connected to the larger figure. The younger Twin is known as "Echo".

case, while I was not aware of the specific interpretation of that particular panel at the time of my visit, I have documented echoes throughout Fremont Indian State Park. The presence of echoes in the vicinity of this panel helps lend credence to the interpretation of the rock art imagery of this panel as containing the Echo Twin.

ACOUSTIC CONSERVATION

Unfortunately, Fremont Indian State Park is a prime example of a rock art site that has had its acoustics compromised somewhat. The visitors' center was constructed so near some of the rock art, that it interferes with hearing the echoing. The building not only blocks the propagation of natural sound reflection from some of the rock art panels, but adds its own artifactual echoes.

The recognition of the importance of echoes to rock art studies immediately implies the need for conserving the natural acoustics of rock art environments (Waller 2003).

CONCLUSIONS

Echoes have been documented at over three dozen echoing rock art sites in Utah, more than any other state except for California (since that is where I happen to live). The first systematic

analysis of a rock art site for the localization of sound reflection was performed in Horseshoe Canyon, and showed that the five art sites correlate exactly with the five locations within the canyon possessing the strongest echoing. Echoes have great cultural significance, as contained in echo myths from around the world, including many from Utah and vicinity. It is theorized that echoing locations such as caves and canyons were considered sacred, and were decorated with images evoked upon hearing the echoes. For example, echo-rich Fremont Indian State Park has a panel that has been interpreted as showing the mythological Echo Twin. The study, appreciation, and preservation of rock art acoustics in Utah are encouraged.

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