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(TITLE)

**ACOUSTICAL CHARACTERISTICS**  
**OF NORTH AMERICAN ROCK ART SITES**

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ABSTRACT

Rock art sites across the United States were measured for sound reflection, including:

- UTAH: Dry Fork Creek at Vernal; Fremont Indian State Park
- ARIZONA: Lomaki in Wupaki National Monument; Honanki and Red Canyon near Sedona
- WYOMING: site #48WE33
- PENNSYLVANIA: Big Indian and Circle Rocks on Susquehanna river

Quantitative sound level measurements objectively document the presence of significant sound reflection. Echoes appear to emanate from the rock surfaces that the artists chose to decorate. Both voice echoes and hoofbeat-like percussive echoes are demonstrable (consistent with the dominant individuals depicted in the art being anthropomorphs and ungulates).

This data, along with measurements previously reported for Europe (Waller, 1993a), plus experience in Australia, suggests a global acoustical motivation for both the subject matter and location of a large amount of rock art. Conservation of acoustical properties of rock art sites is urged.

*Introduction*

This paper about the acoustical characteristics of rock art sites is a continuation of the work that I presented in 1992 at the international Second AURA Congress in Cairns, Australia, in which I described my results of sound level measurements at Upper Palaeolithic sites in Europe (Waller 1992, 1993a, 1993b). This current paper concentrates on the acoustical properties of North American sites I have tested with an improvement in methodology that uses digitized sound spectral analysis.

To scientifically test the hypothesis that rock art locations might correspond to places with significant sound reflection, I have conducted quantitative tests at samples of sites on three continents. I am not the first to notice sound in relation to rock art; after my independent discovery, I found in the literature various mentions of sound: "acoustic space" (Gideon 1957), resonance of musical notes (Reznikoff and Dauvois 1988), "phenomenal attributes" including echoes (Steinbring 1992), etc. What I have done that can be considered different is systematic, quantitative measurements for reflected sound to yield objective data. For this paper, I have selected four of the sites across North America from the list above to present as examples of my quantitative analyses.

*Methods*

A percussion sound similar to clapping was made with a spring-loaded device as a source of a reproducible sound burst. Each experiment was repeated three times to ensure repeatability. In one case (Circle Rock), a natural flute was used to produce a burst of sound at a single pitch to more easily distinguish the cho from background noise. Sounds were recorded on Type II tape with a Realistic Stereo-Mate SCP-29 Model 14-1068A portable cassette recorder using an

omnidirectional Realistic stereo electret microphone model 33-1065. These recordings were digitized using version 1.0 of SoundEdit Pro on a Macintosh PC.

### *Results*

#### 1. Three Kings, Utah

The first example is from the Southwest: the Three Kings panel near Vernal, in northeastern Utah. Like the other petroglyph panels at Dry Fork Creek, I found excellent sound reflection. The Three Kings panel is located 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. As documentation for the echo, I started by recording the ambient background sound, then made a percussion sound similar to clapping, but with 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 result is shown in Figure 1a, 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.

#### 2. Honanki, Arizona

The second example site, also from the Southwest, is at Honanki ruins in central Arizona near Sedona. The spectral analysis as shown in Figure 1b is not quite as visually obvious as the previous example, but reflected sound is demonstrated by a difference of 9 dB above background and is clearly audible. (When a recording of an echo from this site was played to the audience who attended this 1994 IRAC talk, everyone present agreed they could hear the echo.)

#### 3. BLM site#48WE33, Wyoming

The third example site is a canyon designated #48WE33, at the foot of the Black Hills in eastern Wyoming. This is a narrow canyon with many panels of petroglyphs, and each panel I tested gave good echoes. The main panel in particular is located in such a good acoustical environment that BLM personnel had already noticed that even normal conversation produces remarkable echoes. The sound analysis at that location (panel #12) appears in Figure 1c, objectively demonstrating the echo, under these conditions giving a value of 20 dB above background.

#### 4. Circle Rock, Pennsylvania

The fourth example is from small rocky islands in the Susquehanna river on the east coast. At Circle Rock, on which is carved a glyph of concentric circles, one can hear echoes reflecting off the steep rock walls of the river bank. Due to the high background noise level from the wind, for this experiment a natural Native American flute was used to produce a burst of sound at a given pitch (about 3400 Hz) so that the echo could be more easily detected as delayed sound of the same pitch. Figure 2 shows that in this case the delay is quite dramatic at 1.0 seconds long, with the multiple echoes giving a sound level difference of 30 dB above background at the specific frequency of ca 3500 Hz.

#### *Conclusions*

I have heard and recorded echoes at dozens of more sites in the U. S. and am in the process of quantifying the results. These four examples serve to show that rock art across North America have demonstrable sound reflection. Together with the data showing statistically significant sound reflection at European rock art sites (Waller 1992, 1993a, 1993b), and experience at sites in Queensland, Australia (unpublished observations), this work shows that sound reflection is not an uncommon feature of rock art sites.

In conclusion, my data supports a possible global correlation of sound reflection and rock art context, suggesting that one reason sites may have been chosen was because of their acoustic properties. (One aim of my future research is to expand the range of my acoustical testing to include quantitation of the sound reflection in the non-decorated areas surrounding rock art sites. This would objectively support or refute the hypothesis that the artists chose to decorate locations of local maxima of sound reflection -- i.e., the places with the best echoes -- an opinion of mine based on what I have been able to hear myself.)

Echoes and thunder-like reverberation could also be related to the subject matter depicted in rock art, in that echoes can sound like either human voices or hoof beats, which correspond to the major themes of anthropomorphs and hoofed animals. While not necessarily explaining all aspects of all rock art, I recommend that testing for echoing should be included in the study and documentation of each rock art site. Further, conservation efforts should be expanded to include not only maintenance of the graphic art images themselves, but also preservation of the acoustical characteristics of the the site, which may have been an influence in the production of the art.

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REFERENCES

GIEDION, S.

1957. *The eternal present: beginnings of art*. Pantheon, New York.

REZNIKOFF, I., and DAUVOIS, Michel

1988. La dimension sonore des grottes ornées. *Bulletin de la Société Préhistorique Française* 85:238-246.

STEINBRING, Jack

1992. Phenomenal attributes: site selection factors in rock art. *American Indian Rock Art* 17: 102-113.

WALLER, Steven J.

1992. Sound reflection as an explanation for the content and context of rock art.

(abstract) Occasional *AURA Publication* 7:35.

1993 (a). Sound and rock art. *Nature* 363:501.

1993 (b). Sound reflection as an explanation for the content and context of rock art. *Rock Art Research* 10:91-101.

Figure 1. **Audio signals of sounds recorded at** Three Kings site, near Vernal, Utah. Relative sound pressure is indicated on the Y axis, with time in seconds on the X axis.

Figure 2. **Audio signals of sounds recorded at** Honanki ruins, near Sedona, Arizona.

Relative sound pressure is indicated on the Y axis, with time in seconds on the X axis.

Figure 3. **Audio signals of sounds recorded at** Site #48WE33, Wyoming. Relative sound pressure is indicated on the Y axis, with time in seconds on the X axis.

Figure 4. Sound spectrum analysis of recording at Circle Rock, Pennsylvania.

Frequency is on the Y axis, time in seconds is on the X axis, and relative sound pressure is visually indicated by grayscale.