information on the state of consciousness of the subject. From a physical point of view, the mechanical oscillations of the head, is a vibrational process, the parameters of which provide a quantitative correlation between energy and mobility of the object. Such information can be obtained using video analysis Variable Resonance Imaging Camera (TRV) technology, which provides quantitative information of the periodic movements of any part of the imaged object.



Fig. 7 – The TRV camera (left) showing the vibration inside the cathedral (right).

In order to make visible the dispersion effects of air vibrations, a TRV camera (Variable Resonance Imaging Camera, known in Italy as Merlin camera or Defend X system in Japan) was used, along with Vibraimage Pro 8.3 software. TRV video analysis technology, provides quantitative information of the periodic movements of any part of the imaged object. The software can process small vibratory changes in air movement between different video frames, by highlighting the movement and change of chromaticity of pixels in the UV band (Fig. 7). To achieve this, low resolution video is used (640x480) to prevent overloading the computers processing capabilities. Frames are collected and reassembled (standard deviation or STD) to generate a composite video. This technique published in the scientific literature is capable of identifying low vibrations in the environment and has been used to detect deep vibrations caused by the movement of underground water that affects overlying areas ^[13, 15, 19, 20, 24, 26].

The TRV system was used to visually confirm the subsonic vibrations detected on two previous occasions, as well as to evaluate the emotional state of the volunteers on top of Alatri.

Results

In June 2015 our final archaeoacoustical survey at Alatri took place, this confirmed acoustic data previously collected using microphones and a digital recorder and new discoveries by the Geobox.

The ultra-sensitive microphones were connected to two different TEAC Tascam digital recorders. The results showed a loud volume of infrasound vibrations present in the range of 8-9Hz that affected the whole of Alatri hill in the form of non-audible sound (infrasound). Additionally there is a frequency of around 32Hz in the audible field band, recorded during each of our four visits. The volume was between -38db and -42db (Fig. 9) and most likely represents a harmonic of the main vibration. Before recording, a spectrum analyzer (Spectran NF-3010 from the German factory Aaronia AG) was used to search for any electromagnetic phenomena which could have influenced the results (Fig. 8).



Fig. 8 - Spectran NF-3010 from the German factory Aaronia AG.

It is important to discuss these measurements. A distinction between using decibels to measure the sound pressure level (SPL) and using them to the measure signal level needs to be made. SPL is a measurement of the air pressure caused by sound, which results in physical force against the eardrum (or the diaphragm of a microphone). In the acoustic environment this translates to sound volume. Measurements of this type are usually expressed as dB SPL (decibels of Sound Pressure Level). A rock concert typically has a 100db of sound or an average conversation 60-70db of SPL. Low volumes in this field include whispered speech at 20-30 db or a residential area ambient noise at 40-50db. The threshold of human hearing is 0db. When dealing with signal level as opposed to SPL, decibels are used differently; in this case 0 dB is the highest signal level achievable without distortion. All signal levels below distortion are then represented as negative numbers. A volume fader may be labelled with a "0", or a "U" (for unity), part way up to mark the point at which that fader is neither boosting nor attenuating the signal. So a level of -38-42db as found in Alatri acropolis must be considered very high, like a strong ambient noise and can be heard very easily, especially at night in the absence of general environmental noise.



Fig. 9 – Plots of the underground vibrations taken at different times inside Alatri Cathedral. The foundations of this church are dedicated to St. Paul and made from the walls of the ancient pagan temple. In these graphs the frequency peaks at around 8-11Hz and 30-32Hz.

Because of its sensitivity in geologic explorations (using accelerometers instead of microphones), the Geobox confirmed all the frequency peaks found using audio recordings (8Hz and 32Hz), due to the sensitivity of the accelerometers a frequency of 4Hz (non-audible sound) was also discovered. The Geobox made another important discovery, a big cavity below the Acropolis. Such a cavity would function as a giant resonance box amplifying any underground vibrations (Fig. 10).

With the TRV Camera, the infrasound peaks of 4Hz and 8Hz as initially measured by microphones and GeoBox were confirmed. These vibrations appear to affect the entire acropolis and the cathedral in particular. It also appears that there are simultaneous peak frequencies below 4Hz capable of generating vibratory fields in the air (Fig. 11 and 13).



Fig. 10 – The Geobox measurement taken at the "acropolis's navel" (above) and the peaks of absorbing vibration made by the cavity below the hill (below).



Fig. 11 – View of Alatri as taken by the TRV Camera. The arrows indicate the resonance field of 2 Hz above the acropolis and in particular over the Cathedral.

The vibrations were made visible in the UV spectrum using the TRV Camera, which was located at Acropolis's "navel" area, which is deeply immersed in the outcrop rock hill on which the pagan temple was built. This rock works as a transducer for the underground vibrations transmitting them perfectly inside the Cathedral. It is interesting to note these pulsing vibrations are not transmitted to the blocks inside the original pagan temple, which now forms the church basement. The image below shows the blocks of the ancient temple appearing black as taken by the TRV Camera. This indicates a lack of vibration, which is contrary to the underlying rock and due to the fact that the blocks are fitted together, without cement. This actually dampens the underground vibrations and confirms the seismic character of this structure that is still standing after thousands of years and many earthquakes (Fig. 12).



Fig. 12 – Image of the original pagan temple blocks (without cement) positioned to the north of the Acropolis (left). The same image captured by TRV Camera. These blocks appear black in colour because they do not transmit the vibrations coming from below the ground (right).



Fig. 13 – The graph (0.1-12Hz) of the low frequency (subsonic) peaks detectable in the navel area of the Acropolis by TRV camera.

Using the TRV camera on the volunteers, these subsonic vibrations do not appear to create any problem for them. Rather, as with other sacred places, it can be assumed their existence is precisely the reason why the Acropolis and the temple were built in that location as opposed to the neighbouring hills. Anyone who undertakes prayer or meditation inside the church has the potential to feel the effect of these subsonic vibrations, which could ultimately lead to altered states of consciousness, or mystical experiences (usually only experienced after many years of training as with Buddhist monks).

To test this claim, we proceeded to test the depth of meditation that can be reached in a short timeframe with a small number of volunteers (six people), seated on the Acropolis's "navel" (inside the church), and the outcrop rock at the center of the acropolis. Part of this rock protrudes from the walls of the church basement, and part is located deep within the hillside, as such it superbly transmits the subsonic underground vibrations.

The depth of relaxation reached was examined using the TRV camera, whereby the subtle body vibrations were measured, specifically the vestibular organ (inner ear), which regulates balance and spatial awareness. If the subject in question is stressed some imperceptible body vibrations increase and can be immediately detected by the TRV camcorder. However, if the subject is relaxed its vibrations diminish to become imperceptible even to the equipment. This last state is reached only in a state of deep meditation or in the state of vigil prayer.

After a few minutes of meditation, the subject begins to vibrate at a slower frequency (less than one Hz) indicating a deep relaxed state (Fig.4). At this point, it becomes difficult for the TRV camera to distinguish them from the rock. This is known as *entrainment*, a phenomenon in which two or more independent rhythmic processes synchronize with each other ^[17].



Fig. 14 – After a few minutes, the volunteer's vibrational frequency is so low, it becomes indistinguishable from the rock when viewed through the TRV Camera.



Fig. 15 - The geological map of the area around Alatri shows significant movement of the geological faults (in red) which may explain the vibrations measured at the Acropolis (in brown). The arrows placed close to the faults the tectonic show movement direction likely producing the vibrations recorded at the top of the acropolis (map made by geologist Dr. Rocco Torre).

The sound seems to be concentrated solely in the navel of the acropolis and fades into nothing when moving away from it. It is likely the vibrations are coming from the geological faults (Fig. 15) that are very close to Alatri, with their vibrations channelled via some unknown mechanism to the top of the hill.

Conclusion

When looked at alongside research on the effect of acoustics on the human body, archaeoacoustics can be viewed as a method of analysing ancient sites from another point of view. Indeed, its study presents a chance to recover "ancient knowledge" that affects the emotional sphere of human consciousness, as well as to broaden our understanding of the ancient world.

Our methodology using three different approaches has confirmed the preliminary results which were published in 2015^[15]. This focussed on the findings of the TRV camera, which showed some frequencies present at the acropolis capable of entraining the volunteer subjects into an altered state of mind in this case a positive sense of relaxation. The objective findings observed by our devices represent something already detached from subjective perception of the people considered and variously reported with subjective sensations also by the protagonists of our previous research. The continued exposure to the vibrations inside Alatri acropolis has a significant effect on the psyche of those who came for prayer and meditation, facilitating access into a mystical state. Even though they did not have the same equipment we have today, ancient people were aware of the conditions required to achieve such a state, perhaps by simply sensing that in that place they were closer to God. We have also to consider the important discovery of a cavity below the top of the hill working as a musical box for amplifying the natural vibration coming from below.

Archaeaoacoustics is an interesting method of analysing ancient sites to re-discover a forgotten technique that affects the emotional sphere of human consciousness. Ultimately the devices used confirm that a "*mystical*" state can be reached after a few minutes by those who are subjected to the vibration phenomenon inside the acropolis.

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