Definitive Results of Archaeoacoustic Analysis at Alatri Acropolis, Italy

Paolo Debertolis, Daniele Gullà, Natalia Tarabella, Lorenzo Marcuccetti

PAOLO DEBERTOLIS, Department of Medical Sciences, University of Trieste, Italy, President of Super Brain Research Group institution [1]
DANIELE GULLA', forensic researcher, Vice-President Super Brain Research Group institution, Bologna, Italy(*)
NATALIA TARABELLA, architect, bursar of Super Brain Research Group institution, Florence, Italy (*)
LORENZO MARCUCCETTI, historian, member of Super Brain Research Group institution, Florence, Italy (*)

ABSTRACT: Our research group has used archaeoacoustic methodology over the last seven years. Archaeoacoustics has enabled us to explain some of the enigmas of ancient archaeological sites that were not previously possible to explain through other methods. Our hypothesis suggests the exposure to certain non-audible vibrations could have a significant effect on the psyche of those who came for prayer or rituals, facilitating access into a mystical state. Archaeoacoustic methodology was utilised to study Alatri acropolis in Italy. The cathedral of Alatri is located at the highest point in the town of Alatri which sits on top of a Cyclopean temple. We sought to understand why this temple was built in this location. Using a number of protocols we discovered very strong and significant low vibrations (seismic waves) continuously emitted originating from below the ground. Even though ancient people did not possess the same equipment we have today, they would have been aware of the conditions required to achieve such a mystical state, perhaps by simply sensing they were closer to God in a given location. The seismic waves appear to arise from a geological fault located on the side of the hill where the town has stood since ancient times. The presence of such seismic frequencies increases the effect of any rituals by enhancing the psyche of the participants due to their influence on human brain waves. This suggests the builders of this temple had some knowledge of their effect and offers a possible explanation as to why the temple was built on this particular hill and not on any of the surrounding hills.

KEYWORDS: archaeoacoustics, Alatri, polygonal walls, low frequency sound, infrasound

Introduction

Natural sound phenomena were utilised by some civilizations to enhance their rites and ceremonies, indeed some ancient structures were modelled in a certain way to enable the vibrations produced there to directly influence the mind towards a particular state of consciousness. [6,7,8,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,34].

In earlier research, SBRG demonstrated a relationship between mechanical or natural vibrations originating from resonance phe-

[1] Note. Super Brain Research Group (SBRG) is an international and interdisciplinary team of researchers, researching the archaeoacoustic properties of ancient sites and temples throughout Europe and Asia (www.sbresearchgoup.eu).

nomenon at some temples and brain activity. Natural low vibrations with an absence of high pressure can have a positive influence on human health and some people can perceive very low-frequency sounds as a sensation rather than a sound. Infrasound may also cause feelings of awe or fear in humans and given it is not consciously perceived, it may give the appearance that strange or supernatural events are taking place [33]. It is therefore possible to hypothesize that wherever there is a concentration of natural low vibrations, ancient populations considered these sites to be "sacred" [7]. Through archaeoacoustic analysis, it is possible to demonstrate there was some knowledge of acoustic phenomena in the past, which could for example have been used to enhance ancient rituals [6,7,8,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,34].

The historical town of Alatri was analysed from this point of view and with preliminary results published in 2015[15].

In this article the definitive results of this four year research project are presented along with three different research methodologies.

The Ancient Town of Alatri, Italy

Alatri is a small town located in the Frosinone province district, Lazio (Fig. 1). The city of Alatri was built around a small hill, surrounded by megalithic walls and whose remains are mostly visible today. The acropolis is at the heart of the historic centre, on the top of the hill (Fig. 2). The internal perimeter of the acropolis is defined by huge limestone walls forming a polygonal shape which measures 500 meters in length and a maximum of 15.4 meters in height. In addition, the external walls draw a perimeter of 2km made of different stone blocks layers that can be up to 3 meters in height [32].

What is striking is about the huge polygonal "*Cyclopean walls"* is the way the megalithic blocks fit together without the use of mortar, it is impossible to insert a sheet of paper between the joints. The exact date the acropolis was constructed is unknown: some believe the walls were built by the Romans or Latins, others that its origin dates to a pre-roman period, there is however no consensus [29].

Fig. 1 – The location of Alatri, Italy.


Fig. 2 – Alatri town as viewed from a neighbouring hill, the cathedral is clearly visible.

Don Giuseppe Capone was the first to explore the hypothesis that Alatri and its acropolis were built following geometrical

and astronomical lines. In the 1980s, the local monk who served the church-seminary of Alatri for many years, studied further the archaeo-astronomical origins of the town. His observations were confirmed by Antony F. Aveni, professor of Astronomy and Anthropology at Colgate University (USA) in an article in collaboration with Don Capone in 1985 [1].

The fundamental concept inspiring the monk had its roots in the religious culture of the ancient Indo-Europeans. They used the sun as a point of reference by which they fixed certain points on the horizon. This principle appears to have been followed by the builders of the Cyclopean walls. Capone identified a "privileged point" which is located behind the northern wall, at the center of the acropolis. Using this point, he was able to establish that the North-East corner of the acropolis outlines a direction which indicates the rising sun at the summer solstice and that the eastern and western sides are parallel, oriented North-South. In addition, the monk noticed that several doors surrounding the city were located in strategic points and in mutual relation to one another as well as with the map of the city [29].

The Cyclopean walls extend along a North-South axis centered on a solitary rock outcrop, a sacred space reserved for religious purpose located a little higher than the acropolis, a veritable "altar of sacrifice". This rock outcrop (the so-called "*navel*" of the town) appears to be in the center of the ancient city, and is now located outside of the cathedral which was built over the remains of the ancient Temple of the Sun [1,2,3,4]. Perhaps this outcrop was used as a reference point during the construction of the city? This appears to be a plausible as several astronomical observations support this: in the early morning during the summer solstice, it is possible to see the sun rise from the rocky outcrop facing north; the corner of the Cyclopean walls casts a shadow that points directly to the outcrop. Additionally, the east side of the wall turns out to be a fundamental unit of linear measure used in the construction of the acropolis; all the gates and archways in the external wall (with one exception) lay equidistant from the outcrop at three times the length of the eastern inner wall (Fig. 3).

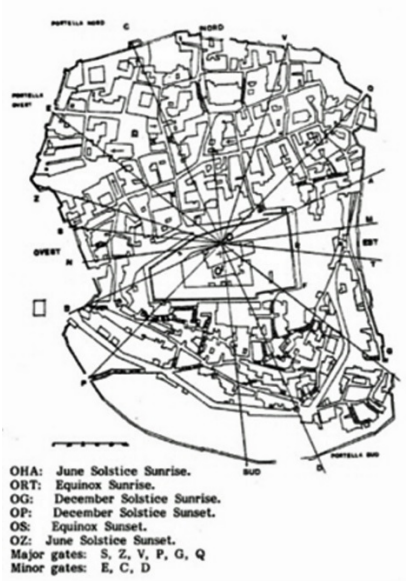

Fig. 3 – The map of Alatri with its astronomical and geometrical indications (Capone, 1982).

Furthermore, the builders of the acropolis divided it into quadrants centered on the outcrop. At the summer solstice sunset, the sun illuminates the city gate of the superior northwest quadrant and its shadow heads directly toward this outcrop. Another gate, "*Porta Minore*" located in the right inferior quadrant attracts further attention: it is a trilithon doorway also called the "*Gate of three phallus*" for a symbol carved over it. On the morning of the equinox in March and December the sun lights the steps that led to the door drawing a perfect rectangular shape outside the gate [1,2,3,4] (Fig. 4).

Fig. 4 – The Minor Gate at the equinox, with the sun lighting up the stairs, drawing a perfect rectangle on the stones in front of it. Over the gate are three phallus carved on the stone architrave. (Courtesy of Ornello Tofani, Italy).

Based on our archaeoacoustic experience throughout Europe [6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,34] we decided to analyze this site starting from the rocky outcrop. Our purpose was to discover why the acropolis was built on that particular hill and not on another of the surrounding hills. Maybe this hill met certain criteria of sanctity for the architect, if so why did he consecrate the acropolis with such characteristics?

Materials and Methods

This research carried out over a four year period, used three different investigative methodologies: *full audio spectrum recording*, a *geologic device* (GeoBox SR04S3 Datasheet) to confirm the audio recording results in the infrasound range and *TRV technology* to analyse the effect of vibrations on the brain. Our research group has used this multi investigatory method previously at various archaeological sites. This experiment was carried out over four visits in different seasons between 2013 and 2016.

The audio recording was performed following the SBRG Standard for archaeoacoustics – SBSA [9]. In this case the equipment consisted of a high range dynamic recorder, extended in the ultrasound and infrasound field with a sampling frequency rate of 192 kHz (Tascam DR-680); Condenser microphones with a wide dynamic range and flat response at different frequencies (Sennheiser MKH 3020, frequency response of 10Hz to 50,000 Hz) with shielded cables

(XLR Mogami Gold Edition) and gold plated connectors.

The microphones were placed at a number of different locations around the acropolis and in the surrounding area to detect any vibrations present. Low frequencies or infrasounds (seismic waves) are non-directional and because they are not easily absorbed by the soil, they travel long distances.

Fig. 5 – The recording operation in the Acropolis's "navel"

A second technology in the form a digital sensor GeoBox SR04S3 Datasheet (Fig. 6) from Italian firm SARA, used accelerometers to acquire audible frequencies specifically in the seismic range. This devise is usually used for seismological and geophysical surveys such as the Horizontal/Vertical Spectral Ratio - HVSR. The SR04 GeoBox is designed especially for recording ambient seismic noise, but it can also record earthquakes and artificial vibrations.

TRV technology (Variable Resonance Imaging Camera), is a methodology we have used for five years. The following is a simple explanation as to how it's applied in our research and how it might be applied within the wider archaeoacoustic field. First off there is a direct correlation between emotional and functional states of the human body with precise parameters of controlled motion reflection. Until fairly recently, quantitative parameters and efficient information of the movement of the human body were not established.

Bernstein and Mira Lopez (psychodiagnostic miokinetics) [30] studied the micro-mobility of the human body and found that it represented a sophisticated mathematical problem. For example, it has been shown that the vertical balance of the human head is controlled by the vestibular system, described as a reflex function, but the balance of the head is also considered an extension of locomotor activity (micro-mobility of the head) controlled by this system. The analysis of this and other types of mobility reflexes provide a lot of

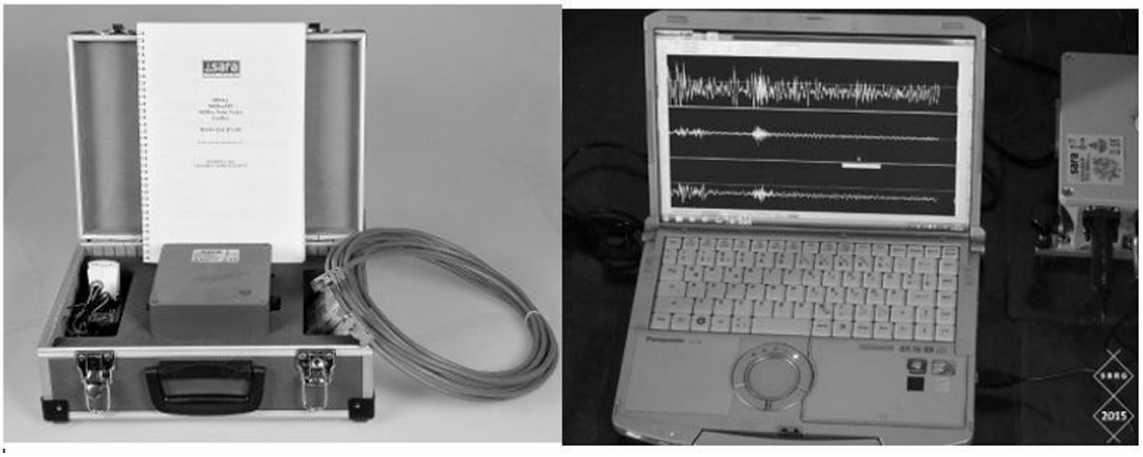

Fig. 6 – Left: GeoBox SR04S3. Right: the GeoBox connected to the computer to investigate vibrations in the acropolis.

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.

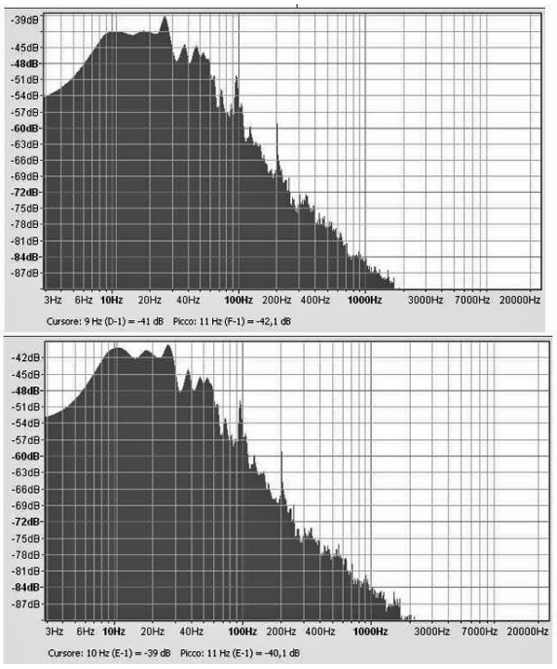

Fig. 9 – Plots of the underground vibrations taken at different times inside Alatri Cathedral. The foundations of this church are dedicated to St. Paul and made from the walls of the ancient pagan temple. In these graphs the frequency peaks at around 8-11Hz and 30-32Hz.

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 partic-

ular. It also appears that there are simultaneous peak frequencies below 4Hz capable of generating vibratory fields in the air (Fig. 11 and 13).

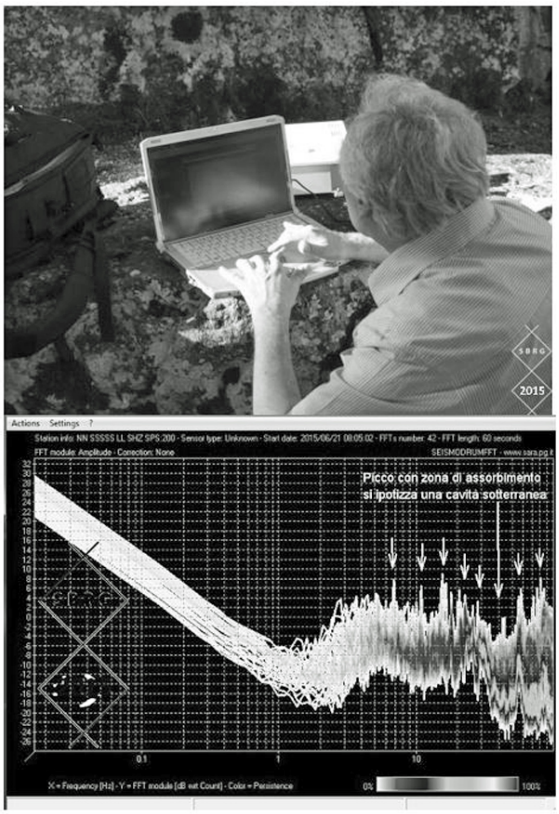

Fig. 10 – The Geobox measurement taken at the "acropolis's navel" (above) and the peaks of absorbing vibration made by the cavity below the hill (below).

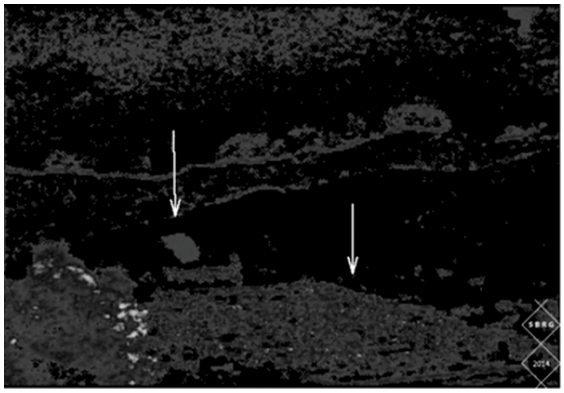

Fig. 11 – View of Alatri as taken by the TRV Camera. The arrows indicate the resonance field of 2 Hz above the acropolis and in particular over the Cathedral.

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).

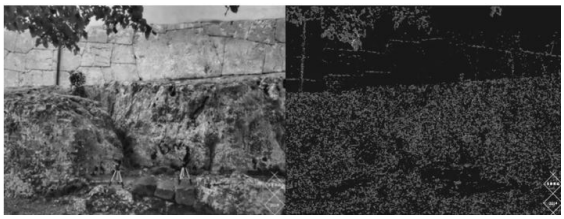

Fig. 12 – Image of the original pagan temple blocks (without cement) positioned to the north of the Acropolis (left). The same image captured by TRV Camera. These blocks appear black in colour because they do not transmit the vibrations coming from below the ground (right).

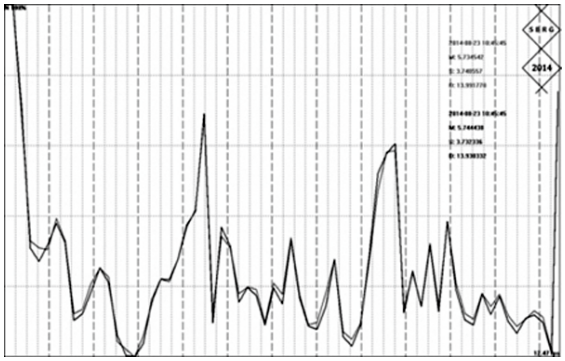

Fig. 13 – The graph (0.1-12Hz) of the low frequency (subsonic) peaks detectable in the navel area of the Acropolis by TRV camera.

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.

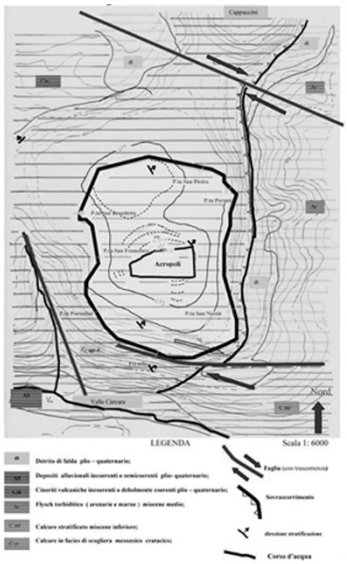

Fig. 15 – The geological map of the area around Alatri shows significant movement of the geological faults (in red) which may explain the vibrations measured at the Acropolis (in brown). The arrows placed close to the faults show the tectonic movement direction likely producing the vibrations recorded 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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