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Archaeoacoustic research in the ancient castle of Gropparello in Italy

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Abstract—Archaeoacoustics provides a way of offering new interpretations on anthropological questions pertaining to ancient architecture and populations. We made an archaeoacoustic analysis of a medieval castle (Gropparello) in Italy built over a likely ancient sacred site known from Celtic period of that area. Our results show a great number of physical phenomena that appear to exist only within the area of the castle but they are not detectable in the surrounding neighborhood. In particular we found infrasounds, audible low frequencies and spiral magnetic fields able to affect brain activity. We can presume that the myth of a sacred site pre-existing in the location where the castle was built is real. The site seems to have the same characteristics we found in other sacred sites in Europe and Asia.

Keywords—archaeoacoustics, Gropparello, vibrations

I. INTRODUCTION

Archaeo-acoustics or archaeoacoustics is a complementary discipline of archeology and anthropology which may help expand our understanding of why certain sites were considered sacred in ancient times. It is a new perspective to analyse archaeological sites which sometimes have interesting sound characteristics [2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]. It may also help to explain why ancient structures were built or carved into the rock. Starting from the premise that past ages were not devoid of noise or spent in silence, we know the human voice used in songs along with the vibrations produced by the musical instruments remained the highest expression of culture for a long period. Natural sound phenomena were used in several civilizations to create impressive rites, with some ancient structures modeled in a certain way to directly influence the mind through the vibrations they produced towards a particular state of consciousness [5,9,10].

In previous researches, SBRG^{*} demonstrated the existence of a relationship between mechanical vibrations from resonance phenomenon at some Neolithic temples and brain activity [5,6,9,10,11,12,14,15,16]. This point of view of ancient sites has had more expansion in the nineties and our research group has

^{*} Note. SB Research Group (SBRG) is an international and interdisciplinary project team of researchers from Italy, Finland, U.K., Croatia, Serbia and Macedonia, researching the archaeoacoustic and anthropological properties of ancient sites and temples throughout Europe and Asia (www.sbresearchgroup.eu).

followed this road since 2010 investigating a large group of “sacred” sites in Europe and Asia (England, Bosnia, Serbia, Slovenia, Macedonia, Italy, Portugal, Malta, Turkey and Greece) publishing our conclusions [2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]. Using modern digital recording techniques, it is now possible to record very clearly non audible sound frequency bands such as ultrasound or infrasound, which are able to modify the brain activity. It is also possible to make it visible and display the magnetic fields affecting the mind; to do so we used UV Imaging, photography and special software to show the micro-movement of air crossed by magnetic forces [14,15,16]. We discovered that the most part of real sites from Gobekli Tepe in Turkey to Tarxien Temples in Malta, from Alatri Acropolis in Italy to Felix Romuliana Palace in Serbia and Epidaurus in Greece are all placed over sources of natural low frequencies or magnetic fields which affect human brain activity and body. We also reproduced the band of vibrations found by other authors in some sacred sites in UK and Ireland in the laboratory and in one sacred site in Italy, confirming that these vibration interfere with human mind in various ways [1,22]. Sometime these bands of sounds have a direct effect on the human body without a person being aware of the associated mechanical vibrations. So after the analysis of about thirty ancient sites the hypothesis of our research group was confirmed and became a thesis. This is: in some archaeological sites considered sacred for thousands of years, there are measurable natural audio phenomena (or magnetic field) that make a place somewhat more mystical than others.

Any severe and artificial extreme sound imposed on the sonic environment has a profoundly destabilizing effect on the individual, indeed infrasound has been used in the context of wars in the area of acoustic weapons [3]. However, 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 [3]. Infrasound may also cause feelings of awe or fear in humans and given it is not consciously perceived, it may make people feel that strange or supernatural events are taking place [25]. So it is possible to hypothesize that, where a lot of natural low vibrations are present, ancient populations considered these sites to be “sacred” [3]. Through archaeoacoustical analysis, it is possible to demonstrate that there was some knowledge of acoustic phenomena in the past, which could for example have been used in ancient rituals [2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]. This same

analysis was applied to the historical castle of Gropparello in Italy.

II. THE SITE OF GROPPARELLO CASTLE

Gropparello Castle is a fortress located in the municipality of Gropparello, Piacenza Province, Emilia Romagna. The name Gropparello derives from the Celtic word “grop”, that recalls a rocky natural obstacle. This lexical origin can be easily explained by the location of the castle on the crest of a rocky spur, 85 meters over the Vezzeno creek. Due to its particular position, the structure remained so long unconquered through the centuries that it became known also as “Rocca di Cagnano”.



Figure 1. Gropparello Castle nowadays

In the ancient times the site was a prehistoric “sacred” hypogeum made of several underground tunnels. Later, the location became a Celtic dominion as we can see from the sacrificial stone located on the opposite side of the ravine.

During the Roman Empire the site was a *castrum*, a structure that defended the way to Velleia, built over the original sacred site. Throughout the IX century the complex was subjected to numerous disputes. By the XIII century the castle served as defensive Guelphs stronghold, passing from a noble family to another.

After several years of conflicts and transfers of propriety, in 1599 Ranuccio I Farnese became the legitimate owner assuming the noble title of Count of Gropparello. Then the aristocrat ceded the castle to the Anguissola family that ruled the fortress until the beginning of the XIX century.

In 1869, under the guide of the new holder Ludovico Marazzini-Visconti, begun the neogothic restoration of the structure by the architect Camillo Guidotti^[26].

Throughout the Second World War the castle was heavily damaged by cannonades that destroyed parts of the walls. In addition the façade was demolished, the battlements and some roofs fell down and the lift bridge underwent further damage.

Nowadays the castle belongs to the Gibelli family, which has thrown it open to the public.



Figure 2. Soldiers inside the castle in the Second World War (source: 8 agosto 1944, Gropparello liberata)

III. MATERIALS AND METHODS

For the recording sounds we used two types of dynamic high-end microphones extended in the ultrasound field together principally with a digital portable recorder with a maximum sampling rate of 192KHz (Tascam DR-680 of TEAC Group), but we controlled the result with other digital recorders (Tascam DR-100 and Marantz PMD661) with less technical characteristics.

At the same time for the recording in the air we used professional studio microphones with a wide dynamic range and a flat response at different frequencies (Sennheiser MKH 8020, response Frequency 10Hz - 60.000Hz) along with shielded cables (Mogami Gold Edition XLR) and gold-plated connectors (Fig. 3).



Figure 3. The set-up used for recording sounds: the recorder Tascam DR-680 and microphones Sennheiser MKH 8020.

For the recording in water of the well we used ultrasensitive omnidirectional microphones also used by sea biologists (Aquarian H2a-XLR Hydrophone, frequency response from 10Hz to 100Hz) with a factory shielded waterproof cable. This type of microphone has a wide bandwidth typically used to hear whale song up to several kilometers away. In this case the sound is transmitted very quickly in water, with the body of water acting as a reflector capable of capturing any vibration many meters away (Fig. 4).



Figure 4. **Above:** The Aquarian H2a-XLR Hydrophone. **Below:** Two microphones Hydrophones were placed in the main well of Gropparello castle.



Figure 5. Spectran NF-3010 from the German factory Aaronia AG.

Before recording we used a spectrum analyzer (Spectran NF-3010 (Fig. 5) from the German factory Aaronia AG) to search for electromagnetic phenomena present around us which could have had a negative influence on our results.

Praat program version 4.2.1 from the University of Toronto and Audacity open-source program version 2.1.2 for Windows and Linux were used to analyze the various recorded audio tracks.

We also used a geologic device for confirming what we found by microphones in infrasound range. It is GeoBox SR04S3 Datasheet from Italian firm SARA (Fig.6). The digital sensor SR04 GeoBox is a high-performance instrument especially suitable for acquiring signals 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. Compact, reliable and simple, it is fully functional within minutes after deployment.



Figure 6. **Left:** GeoBox SR04S3. **Right:** the device connected with the computer at work for investigating vibrations in the basement of the castle.

To make visible the shape of the magnetic field, we used UV photography and a vector program for PC (PIV – Particle Image Velocimetry). This consisted of a modified Canon EOS 1100D digital camera, with its anti-aliasing filter removed. The camera used was modified in Canon's Italian factory. Any new camera can be modified in this way, however Nikon, Sony and Olympus cameras can only be modified by a private technician automatically invalidating the warranty of the firm, and the camera can lose some characteristics necessary for scientific use. In the ultraviolet band (UV) the absorption of lenses of normal optics (lenses without calcium fluoride and quartz for forensic use) is very strong, usually a normal optic is unable to allow electromagnetic waves below 320-350nm to pass through, but it is sufficient for analyzing the UVA band (400-315nm) where it is possible to perceive the movement and the behavior of dust suspended in the air, and gas flows as a water steam which orientate itself as a dipole in the magnetic field [14].

Particle Image Velocimetry (PIV) by Dantec Dynamics from Denmark is the software used to analyze this movement in the UV video and photographs taken. PIV is used in industry as an intuitive measurement technique to measure two or three components of velocity in a variety of flows. The application of PIV in research and industry is widespread, due to its ease of use and accurate data representation. As easy and intuitive as PIV is, it involves many cross-disciplinary challenges, from classical optics and imaging to the use of dedicated state-of-the-art digital electronics and lasers. The principle of PIV working is very simple: two consecutive shots illuminate a slice or volume of a flow field with particles suspended in the flow. The scattered light from the particles is recorded in two consecutive images on one or several digital cameras. The images are sub-divided into smaller areas to calculate the mean particle displacement between two corresponding sub-areas. The particle displacement is calculated using cross-correlation or Least Squares Matching techniques. Since the time between the shots is known, the particle velocity can be determined. Taking into account the magnification of the optical setup, the

absolute velocity field can be derived. The velocities calculated from an image pair are an instantaneous snapshot of the flow viewed by the cameras. PIV results are an accurate representation of the flow presented to the user and viewers in an easy to understand and visual manner. The presentation is aided by advanced soft-ware post-processing. Dantec Dynamics is the leading provider of laser optical measurement systems and sensors for fluid flow characterization and materials testing (Fig. 7).



Figure 7. An interesting spiral magnetic field was found at the entrance of the castle by UV Imaging (UV camera and PIV software).

In order to make visible the effects and dispersion of vibrations into the air a TRV camera (Variable Resonance Imaging Camera, known in Italy as Merlin camera or Defend X system in Japan) was used, along with specific annex software, Vibraimage Pro 8.3, able to process the minimum vibratory differences present in the air resulting from the movement of air molecules visible only instrumentally in the various frames of videos. The software connected to the TRV works by highlighting the movement and change of chromaticity of the pixels of the collected image in UV band (Fig. 8). For this, a lower resolution is used (640x480) to avoid overloading the computational power of the computer. Reassembling the frames collected one after the other (standard deviation or STD) we have an image in the air of vibrations spreading from underground. This technique, already widely used in previous investigations and published extensively in the scientific literature ^[5,6,10,14,15,16] has been able to detect deep vibrations from the movement of underlying thermal waters that invest the overlying areas. In this respect, it has proven to be a reliable technology. Information on the integral parameters can be obtained using video analysis TRV (Variable Resonance Imaging Camera) technology, which provides quantitative information of the periodic movements of any part of the imaged object.

The TRV image analyser system is used to monitor vibrations in normal or altered state. The change from the initial multicoloured image to a single colour state indicates that the vibrations have passed from a wide spectrum to a narrow spectrum of frequencies, which indicates a state of coherence in the examined object. As a result, the detected

frequency spectrum changes completely when the examined subject enters into an altered state of vibration. All the parameters are analysed and stored from moment to moment by the cameras software. At the end of the trial a "report" is generated showing the spectrum of vibrations.

The pictures below show a distribution of horizontal coloured stripes around the vibrating subjects (the numerical row shows the obtained individual frequencies). These represent the spectral distribution of vibrations in a band between 0.1 and 10 Hz according to a scale of pseudo colours from purple to red (Fig. 8). The algorithms for determining this are based on a mathematical statistical system.

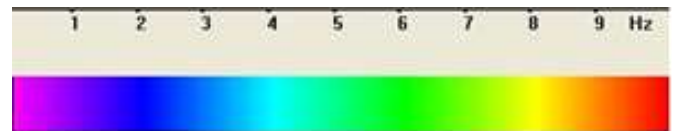


Figure 8. Images converted to a scale of pseudo colours in relation to frequency measured in Hz.

The TRV system's camera has a common CCD backlit, with a three MegaPixel sensor. The protective anti-aliasing filter was removed to extend its vision beyond visible light into the infrared (IR) and ultraviolet (UV) range the lens is a 25 mm quartz-fluorite with passband from 200nm to 1800nm. It is connected to a PC ^[15].

This system was used to visually confirm the subsonic vibrations detected in the two previous methods, as this device is also capable of identifying the dispersion of low vibrations in the environment ^[10,15,16]. This extended application is the same used in engineering to value the vibrations of a structure, for example of a bridge ^[15].

IV. RESULTS

All the equipment used detected some interesting vibrations from underground (Fig. 9). Examining the different rooms of the castle from the basement to the 2nd floor there was always present a dominant sound of 33-34Hz, then in audible band, surely due to the movement of underground water accompanied by two other peaks of vibrations around it at 23Hz and 43Hz, which formed a curious trident aspect on sound spectrum.

There was also present a peak of infrasound with a range between 8Hz and 11Hz just a little bit lower.

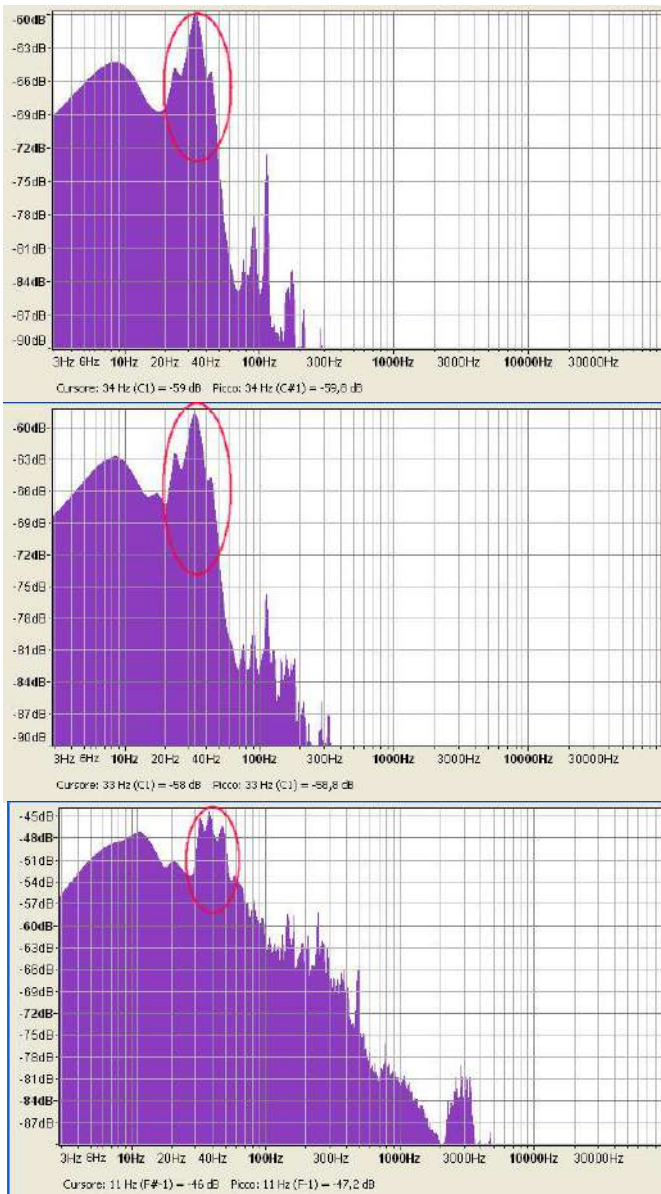


Figure 9. The curious aspect of a constant peak of sound around 33-34Hz at different volume from -60db to -45db visible in every room of the castle, but depending from the nearness of the room to the subsoil.

We obviously recorded different volumes in respect to the location of the room.

The geologic geophone confirmed the data and revealed a fairly narrow band of vibration. But above all it sets out the possibility of underlying cavity yard, i.e. prehistoric excavated tunnel, now no longer viable, that are clearly highlighted by the geophone graph.

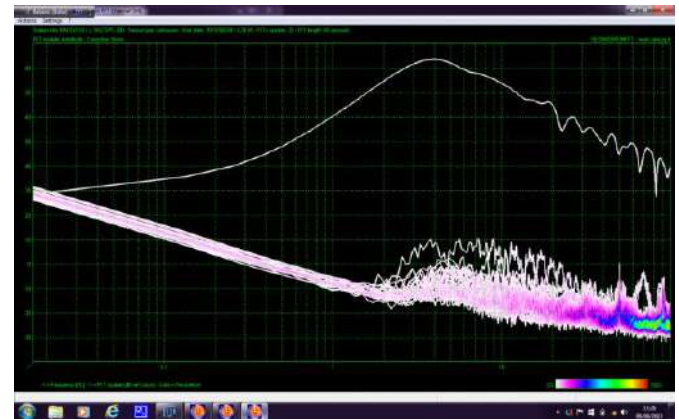


Figure 10. The aspect of resonance coming from a cavity or more cavities placed below the castle. It appears by the space between the lines of vibrations at the right end of the graphic.

The TRV camera is to highlight the spread of vibration in video with the overlap of about 30 frames for second. They appeared as the "bubbles" accompanied by a moving magnetic field that causes a change in intensity of the brightness of the pixels in the camera sensor. We cannot perceive this change in brightness by naked eye, but only the computer and dedicated software are able to see it producing amazing images as below (Fig.11).



Figure 11. The spread of vibrations in the main room of the castle.

With UV Imaging we found various spiral magnetic field in the area of the castle. The most powerful electromagnetic field was found in the courtyard just in the center of the castle.

This type of phenomena was visible also in the chamber of the castle, for example in the ancient basement of the castle where the original Roman tower was built. In that location is now placed a great organ that was switched off during our measurements so it did not influence the data.



Figure 12. The courtyard of the castle with a strong spiral magnetic field just in the centre visible thanks to the use of PIV software in UV Imaging.



Figure 13. The ancient basement of the medieval castle where Roman tower was originally built.



Figure 14. The same frames of Fig. 13 examined by Vibraimage Pro software which highlights the micro-movements in the air caused by spreading of vibrations.

In our research across Europe this kind of vibration (we highlight mechanical stress and not electromagnetic waves) and magnetic phenomena have been found at a number of other

locations deemed "sacred" and perhaps for this very reason was in some way revered by ancient people [2,3,4,5,6,7,8,9,10,11,12,13,14,15,16]. Inside the basement the TRV camera observed that the vibrations seem to spread in the air causing abnormally funny morphologies to move in a curious way (Fig. 14).

V. DISCUSSION

After six years of experience of archaeoacoustic analysis in various sacred sites in Europe and Asia we can confirm that every sacred site was chosen by ancient people for the extraordinary physical phenomena existing in those locations. These physical phenomena had a direct effect on human brain activity causing from an altered state of mind to a mystic ecstasy. There is no doubt that in Gropparello castle there are a great number of physical phenomena in all parts of the structure and in particular where the most ancient settlement was built: the ancient basement below the Roman guard tower.

Secondary, we can confirm the myth of some artificial cavities that were dug in Prehistoric time by initiated people who wanted to be in contact with an underground world. We cannot say if the cavities we found by geophone are natural or artificial, but we can confirm that they exist. We suggest a deeper research by georadar for defining the exact location of them and a possible lost entrance below the basement of the castle. For sure these cavities were the nucleus of the sacred site and could reveal the discovery of ancient remains of a more ancient civilization.

We can also confirm that the curious hallucinations that some visitors perceived and reported in several episodes, while visiting this site, could have been caused by the altered state of mind reached as a consequence of the physical phenomena we discovered.

VI. CONCLUSION

Archaeoacoustics provides a way to offer new interpretations on anthropological questions pertaining to ancient architecture and populations. After our investigation on Gropparello castle we can confirm that the ancient castle, or better the location where the castle is based, has all the characteristics of an ancient sacred site of the remote past. The possibility to reach an altered state of mind by natural phenomena existing in this location in particular conditions is very high. We can say that especially if the ancient people tried to reach it during rituals in underground cavities where vibrations and magnetic fields had the maximum power. There are also various scientific papers which confirm the connection between brain activity and natural physical phenomena [117,18,19,20,21,22,23,24,25].

So we can conclude that this site, together with the ancient Celtic sacrifice altar placed in front of the castle on the other side of the ravine, were probably very ancient sacred locations of which their origin is lost in the past. The high number of vibrations perceived both in subsonic and audible band and the magnetic fields suggest the idea that through these phenomena the ancient population was able to influence the perception of the human body to obtain different states of consciousness without the use of drugs or other chemical substances making their ritual very impressive.

Our research demonstrates that archaeoacoustics with its effect on the human body, appears to be an interesting new method for reanalysing ancient sites in order to re-discover a forgotten method that affects the emotional sphere of human consciousness. Modern recording technology is now able to give greater clarity to the origin of many interesting phenomena, reaffirming the aura of legends that pervades some sacred places.

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