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Summary

Dear Reader,

it is our pleasure to introduce you this proceedings. This book contains all accepted papers from conference, which is described below in more details. We hope published papers contribute to the academic society and provide interesting information for researchers world wide.

Conference details:

- Conference full name: **Scientific Conference**
- Conference short name: **SCIECONF**
- Conference edition: **4th**
- Conference dates: **June 6 - 10, 2016**
- Conference web page: **www.scieconf.com**
- Conference online archive: **www.scieconf.com/archive**

Conference paper approval process:

Each registered paper was evaluated in double tier approval process.

1. Scientific Committee evaluation (in average 2 reviews were prepared per paper).
2. Conference Editorial Board.

Only papers recommended by these committees were accepted for online presentation at the conference and for publication in this conference book.

Conference presentation:

All accepted papers were presented at the conference during conference dates. Asynchronous online chat was prepared for each paper, where all conference members could freely discuss the topic. During the conference, the Section Chairmen Committee steered the conference discussion. Short presentation were proposed for effective conference discussion.

Conference post processing:

- Each published paper is available in **CDRom** and **online** proceedings (online archive).
- All papers in online archive are available for downloading for potential readers (**open access policy**).
- For effective linking and citation each paper is provided with **DOI**, we recommend to use DOI for referencing.
- The online archive may be possibly evaluated by several Abstracting and Indexing services in future.

Sincere thanks for:

- **Scientific Committee** and **Section Chairmen Committee** for their volunteer work during reviewing.
- Conference **partners** for promotional work and their contribution.
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Stefan Badura
Conference Organizing Committee
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Healing aspects identified by archaeoacoustic techniques in Slovenia

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Abstract—**Over the years, SB research group has carried out investigations at two Romans archaeological sites with thermal baths; in Serbia in 2013 and more recently the Laško area in Slovenia. In both cases we found the positioning of the Roman baths is to be much more than a purely random act. It is believed that empirical knowledge of thermal waters (orgininating from the Etruscans) was utilised by the soothsayers of the Roman Empire, the augers, to locate the baths to obtain the maximum benefit from there natural wellbeing properties. Using advanced devices we added weight to this hypothesis through use of archaeoacoustic methodology.**

Keywords – archaeoacoustics, infrasound, Roman baths

I. INTRODUCTION

Archaeo-acoustics or archaeoacoustics is a complementary discipline of archaeology and anthropology which may help to expand our understanding of why certain structures were built at particular sites in ancient times. Natural sound phenomena were used in several civilizations to create impressive rites, with some ancient structures designed in a such a way as to directly influence the mind through the vibrations they produced towards a particular state of consciousness [10,18,19].

In previous research, SBRG demonstrated a relationship between mechanical vibrations present at some temples and brain activity [4,5,6,8,9,10,12,13,14,15,16,17,18,19]. 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 [5]. 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 [5]. Infrasound may also cause feelings of awe in humans and given it is not consciously perceived, could potentially cause people to feel like strange or surreal events are taking place [5].

At the end of July 2015 some members of SBRG group, went to the North of Slovenia for an archeaoacoustic assessment of Roman baths located in the area of Laško. In previous research carried out at the ancient Roman site of Felix Romuliana, Serbia (P. Debertolis, M. Zivic, 2015) [15], we hypothesized that the construction of a sacred temple inside the palace by Roman architects was deliberate. With both its location and orientation taking into account the presence of underground water, the vibrations of which can affect the psyche (for example of ritual officiants within the building). Such vibrations are caused by the movement of underground water which eventually emerges to the surface close to this temple and lead to the construction of a thermal plant inside the palace[15].

The hypothesis expands on this stating the architects of the time, a particular category of soothsayers, called *àuguri*, had the ability to detect local physical phenomena (such as groundwater or tectonic vibrations) using various methods of divination. Because of their potential impact on health assisting or harming those who stayed in their presence, similar divination techniques were used to find the optimal location for a military camp[15]. Nowadays the study of geopathic stress, as a complementary science to medicine, is relatively new and in many medical circles still not recognized [24]. In contrast, ancient Romans who were familiar with this gave due consideration as to the exact site of a particular public building, military field or spa[15]. Anyone who is able to detect natural earth vibrations, or rather natural disturbances in the earth magnetic field (such as those created by the presence of underground water or geological faults), can determine if they have a positive or negative effect on health. One of the central concepts of natural disturbances is that power spots exist where they cross. A theory first proposed by early twentieth century researcher Alfred Watkins[32] in which he discovered long straight tracks connecting sacred sites. Researchers such as Jacka[25], Nixon[30] and Wheatley[33] suggest these lines have a beneficial effect on human health. The negative affect such earth vibrations have on the human body are known about from research into geopathic stress[23,24,26]. The Greek origin of the word 'geopathic' literally means suffering or disease from the earth, geo 'of the earth' and pathos 'suffering'[23]. Geopathic stress can originate from man made activity such as mining activity or from natural disturbances in the earths magnetic field such as geological faults or subterranean underground water[23].

To explore this hypothesis further, we went to the Laško spa area, where a thermal plant built over the original Roman baths exists. We analyzed the Rimske Terme Hotel with the owner, located over the original Roman settlement to perform an analysis of the vibrations present in the eighteenth century stone baths (replacing the original Roman ones in the same location).

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Figure 1. The Rimske Terme Hotel Spa built right on top of the ancient Roman baths and integrates also the original tanks. It is nestled in the wood and has a large garden.

The analysis was extended to include the garden surrounding the hotel, which once housed a number of other Roman buildings and where for centuries exotic trees such as redwoods have stood. The spa is open today, in the 18th and 19th centuries, it was reserved for kings and nobles, including Josephine Bonaparte Murat, wife of the king of Naples and sister of the more well known Napoleon I, Emperor of France.

Figure 2. The original bath used by Josephine Bonaparte with a commemorative plaque in German above it.

II. MATHERIALS AND METHODS

Our study is focused on the research of natural earth vibrations (disturbances in the earths magnetic field) in the audible and inaudible sound band (infrasound and ultrasound) through use of highly sensitive water microphones (Hydrophones from American firm Aquaria) and a high range dynamic recorder, extended in the ultrasound and infrasound field with a sampling frequency rate of 192 kHz (Tascam DR-680). These hydrophones were positioned within the stone spa baths that were filled with water. These Roman stone baths remain buried and represented ideal transducers to collect subsurface vibrations which are better transmitted through the water. Measurements were taken only after the stone baths were filled, allowing time for any parasite sound from the pipes to dissipate.

Audio recordings were also taken outside the building over a Roman bath following the SBRG Standard for archaeoacoustics – SBSA[7]. In this case the equipment consisted of 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.

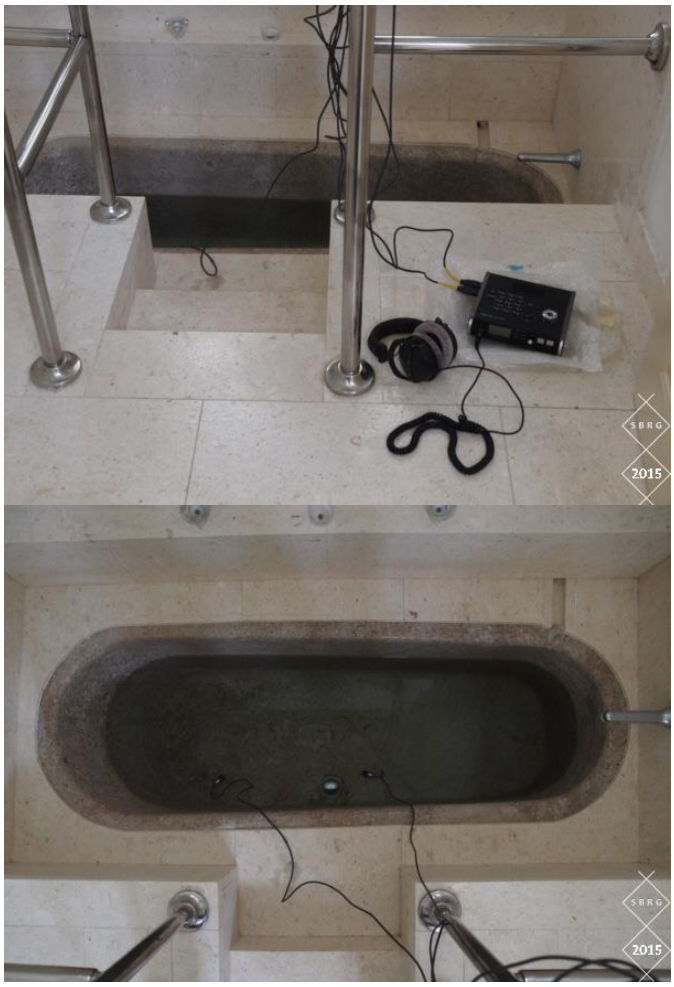

Figure 3. Top: the recording equipment Tascam DR-680 connected to the ultra-sensitive microphones. Bottom: the microphones(hydrophones) placed inside the tanks totally submerged in the water.

As a second method, we used a professional three channel equipped geophone with dedicated software, Geobox SR04S3, from Sara Electronic Instruments inside the building, but not immersed in water as it is a highly sensitive instrument. Such equipment is used in the field of geophysics to identify the presence of tectonic or underground water through detecting vibrations in the range of 0.1Hz and 600Hz, and widely used in the field of seismology to detect earthquake swarms as precursors of earthquakes. The geophone was used so that two different research methods could be compared.

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In order to make visible the effects and dispersion of vibrations into the air a TRV camera (camera variable resonance, known in Italy as Merlin camera or Defend X system in Japan) was used, along with specific annex software able to process the minimum vibratory differences present in the air consequent to the movement of air molecules visible only instrumentally in the various frames of video. 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. For this, a lower resolution is used (640x480) to avoid overloading the computational power of the computer. Reassembling the frames collected one on the other (standard deviation or STD) we have an image in the air of vibrations spread from underground. This technique, already widely used in previous investigations and published extensively in the scientific literature[8,11,14,18,19] has to date 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 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 (rows show 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 (shown below). The algorithms for determining this are based on a mathematical statistical system.

Figure 4. 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 [11]. It has a system of rotating LEDs from infrared to visible light which generates ultraviolet light and synchronises it to the lights rotation at will from 1 Hz to 10 KHz. The lens is a 25 mm quartz-fluorite with passband from 200nm to 1800nm. It is connected to a PC, but videos can also be saved to internal flash memory [8,14,19].

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 [8,14,16,19]. This extended application is the same used in engineering to value the vibrations of a structure, for example of a bridge [19].

III. RESULTS

The old stone baths in the oldest building and the small rooms inside were examined. All the equipment used detected deep infrasounds (inaudable sound) from underground. It is conceivable that when the human body is immersed in the thermal water, it is invested integrally by certain vibrations which have an effect on the physical body generating a sense of wellbeing.

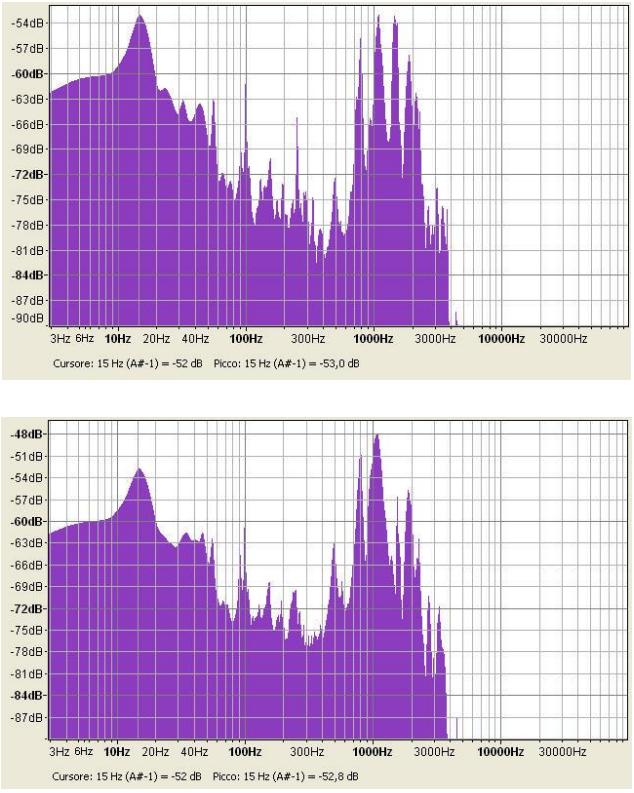

Figure 5. A peak of around 14-15Hz is constant and more or less at the same volume level (-53db) in all stone baths examined to date and is accompanied by various ambient noises. In this case from the fall of a drop from the tap in the bath full of water that generates a peak between 1,000 and 3.000Hz.

Depending on the ambient noise, this level of peak appears to be constant in volume oscillating briefly around 14-15Hz. It is sometimes accompanied by various other spurious vibrations, but with irrelevant content for the inconstancy and inconsistency of these. This kind of vibration (we highlight mechanical stress and not electromagnetic waves) has been found at a number of other locations deemed "sacred" and gives rise to a feeling of wellbeing, that perhaps for this very reason was in some way revered by ancient people.

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Of interest to note is that the maximum length of time guests are advised to stay in the bath is 20 minutes (due to the high water temperature). However, the exposure to these infrasounds for prolonged periods can overload the human body by creating a disease [6]. Inside the pavilion with its small rooms containing the hot baths, the TRV camera observed that the vibrations seem to spread in the air causing abnormally funny morphologies to move in a curious way.

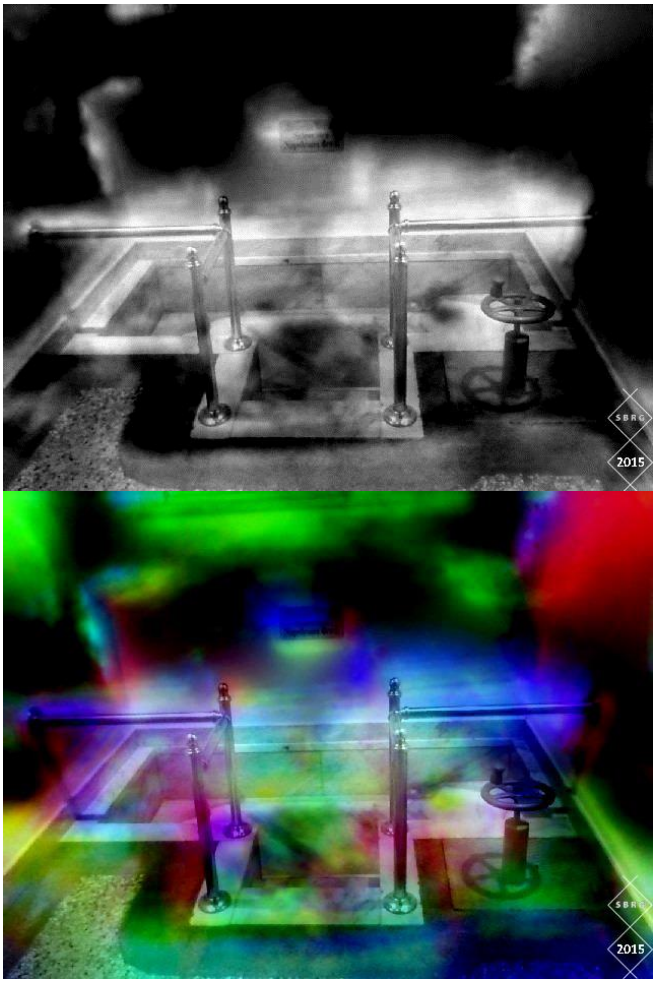

Figure 6. The same bath from Figure 2 taken by TRV camera in the UV band. **Above**: the spread of vibrations in the air in black-white image. **Below**: the same image but in which through the color it is possible to distinguish the vibration frequency (higher red, blue lowest). The areas in black appear unexplained.

Outside of the small rooms these vibrators are also detectable, as an unexplained phenomenon that appears on the TRV camera as vibratory "holes" in which the vibrations appear to focus. The TRV camera was repeatedly controlled, however, the same results were obtained. Software or hardware errors were ruled out and for now these images are difficult to interpret.

Figure 7. The entrance hall of the pavilion that includes the thermal baths taken in the visible band (**above**) and in UV band after the TRV camera processing (**below**).

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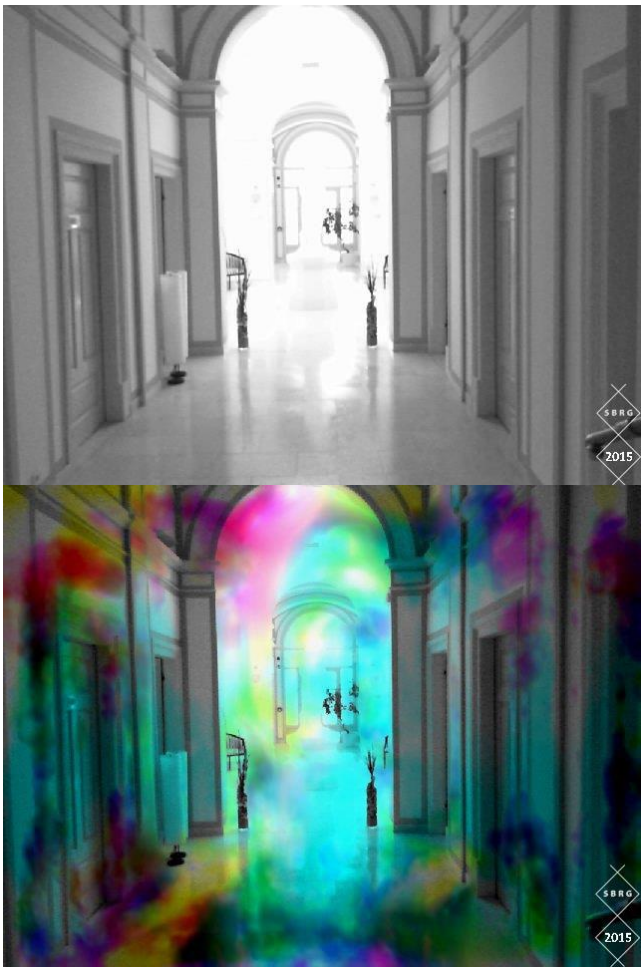

Figure 8. The same big room of Figure 6 taken from another angle in the visible band (**above**) and in UV band after TRV camera processing (**below**).

The data obtained from the geophone correlates with the same taken from the microphones and digital recorder. In the plot below, the geophone was positioned on the marbled paved flooring next to the baths, a peak of around 14-15Hz is recognizable along with a series of noises between 4-11 Hz. There is no significant peak that remains constant in time for which a specific meaning can be attributed (Fig. 9).

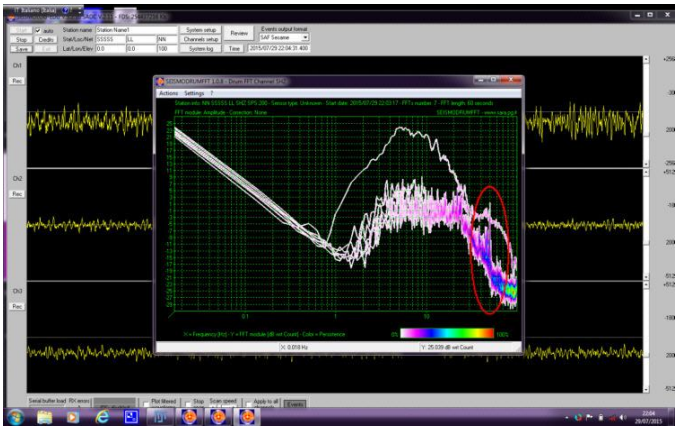

Figure 9. **Above**: the graph from the geophone in one of the baths. Highlighted in red is the 14-15Hz with a variable volume. It follows an indistinct line of noise between 4 and 11 Hz. **Bottom**: analytical operations through the geophone.

This particular vibration was not found to be present outside the pavilion in the garden in front of the hotel. Other types of vibrations however, were detected by German researchers that most likely marked the most salient positions the water is channeled at various locations, (these results have yet to be published). Within the reported locations of the German researchers, it was possible to detect a considerable variability of high volume peaks at significantly different frequencies indicating the different morphology of the sub-surface soil along with a generation of certain sounds originating from an underground thermal spring.

Figure 10. The no. 1 position detected by German researchers is indicated by a notice.

The 'no.1' position in the garden of Rimske Terme, with evidence of a high volume vibration of 29Hz (Figure 10), most likely originating from the underground thermal water, capable of generating a magnetic spiral disturbance, something that has been well-documented using UV band photography and video and by computer analysis according to the Block Matching method[34] (Figure 13).

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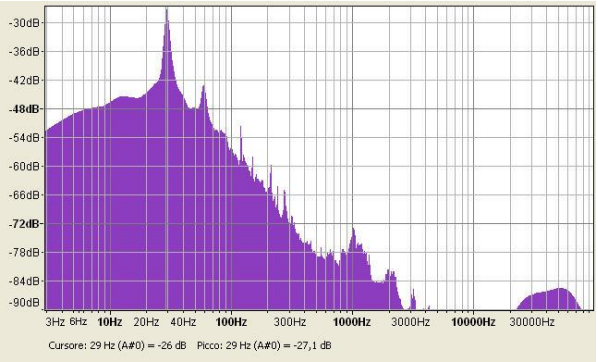

Figure 11. In the point no. 1 the detected frequency appears constantly around 29Hz at high volumes (-30 dB).

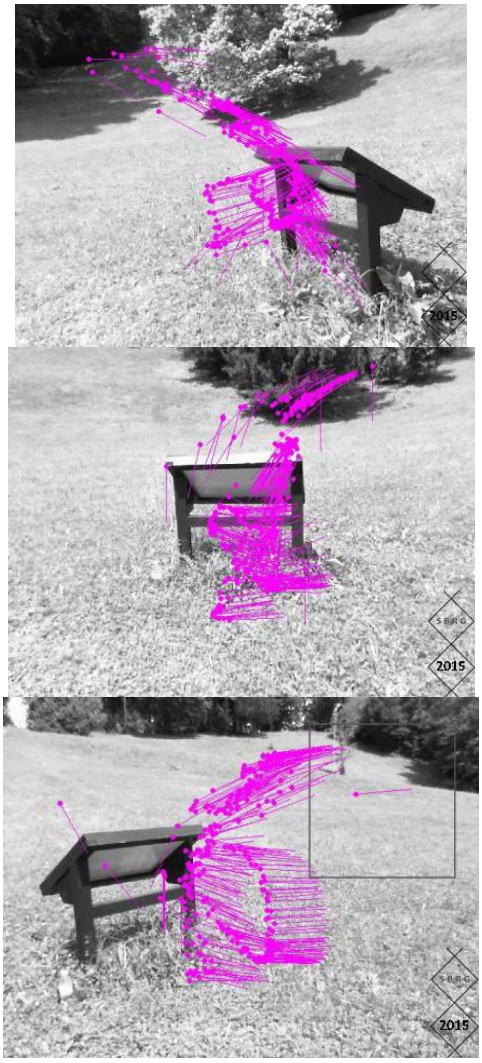

Figure 12. Point no. 1 in Rimske Terme garden taken from three different locations. In front, a magnetic spiral field generated by the groundwater, identifiable by TRV camera and the Block Matching technique.

The *Block Matching* method [34] divides the image into areas (blocks) associated with the detection of air movement that changes the brightness of the pixels within the digital image. Software calculates the estimated motion of air particles in a magnetic field by comparing the previous frame (where the image is separated through giving a value to an area) then sliding the pixels to obtain the maximum displacement area (Figure 13). The difference in pixel brightness is determined by the steam present in the air particles which naturally tend to form in a similar fashion to a dipole in a magnetic field. This micro movement is not perceived with the naked eye, but can be detected by the camera. The frames obtained from the video are individually analyzed and placed on the stack by the software (which is somewhat slow due to the huge amount of data processing required) [34].

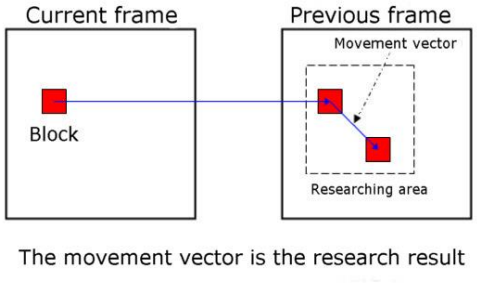

Figure 13. Analysis by software system named Block Matching.

At the other points investigated in the hotel spa garden, especially at points 3 and 6 (where the German researchers detected infrasounds from underground water), powerful noises (maximum -45dB) were detected at different frequencies from the 14Hz found within the thermal baths. The vibrations in the garden have a very original dispersion and UV band analysis by the TRV camera generates very strange shapes.

Figure 14. The garden adjoining Rimske Terme. The person sitting at the base of the tree in the foreground gives an indication of the size of the centuries old redwood trees.

Figure 15. The dispersion of vibrations inside the garden next to the hotel.

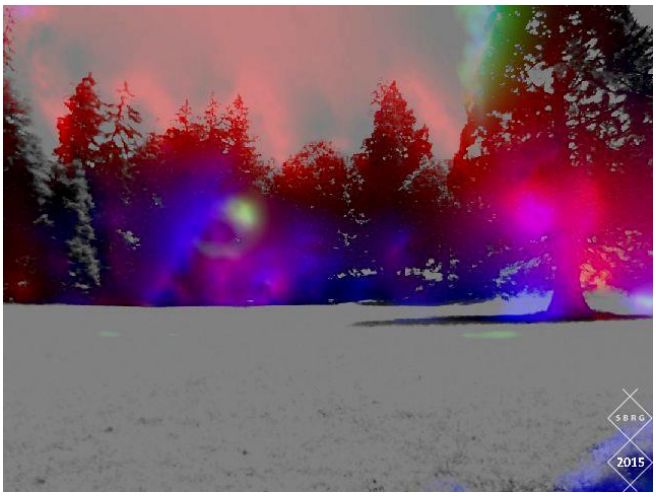

Figure 16. Dispersion of the vibrations in the garden taken in a shooting image at eye level.

The findings from the geophone more than one kilometer from the thermal center have shown that the vibration flows emanate from below the surface and are completely different and devoid of interest from the psychophysical point of view.

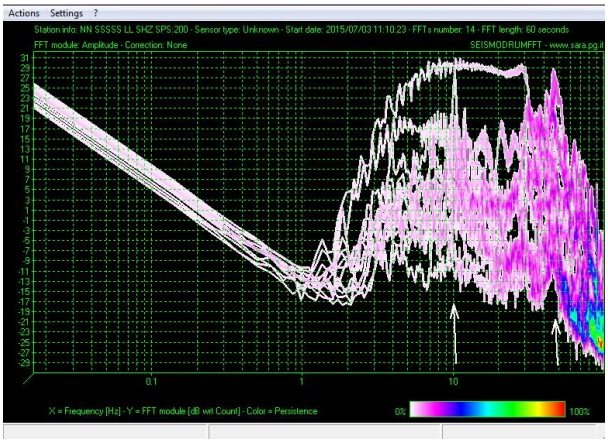

Figure 17. Surveys carried out 1 km away from the spa: there are not vibrations having a profile for psychological well-being.

IV. Discussion and Conclusions

As with previous research carried out in Serbia in 2013, the positioning of the Roman baths in the Laško area does not appear to be random. The presence of infrasounds in the areas examined by our instruments can change the state of consciousness and mood of exposed people to create a sense of wellbeing. In particular, the thermal baths area with its 14Hz infrasound frequency is has a definite positive effect on the human body [5,6,9,10,12,13,14]. A few studies have attempted to measure the biological affect of natural earth vibrations, specifically Geophatic stress on humans (Dharmadhikari, 2010[20]; Dharmadhikari, 2011[21]; Hacker, 2005[24]), however much less is known about their affect on the human psyche, something that this research is attempting to do. But such phenomena was known to the Chinese over 4000 years ago, who avoided building houses on places with GS, did the Romans also make use of this knowledge? How was it that nearly 2,000 years ago the ancient Romans were able to find this benefical location without use of the measuring devices we have today? As we said in the introduction, the Roman architects of the time were a particular category of soothsayers, called *àuguri* (augurs) who had the ability to detect such vibrations using various methods of divination. Such techniques were used to find the optimal location for a military camp, public building or spa being careful to avoid any potential negative impact on health[15]. It is believed that through the use of empirical knowledge of thermal waters oringally held by the Etruscans, combined with the use of the soothsayers, the Romans had a high regard for them. These augurs were a class of priests; Titus Livius wrote in his book "*History of Rome*" that no decision on war or peace was taken in ancient Rome before consulting the "*collegium*" board (Titus Livius, Book VI) [29]. This college was formed of fifteen members chosen by the 'dictator' Silla, whose decisions (which were not about predicting the future), were required for the "approval" of the Gods (Titus Livius, Book I) [28]. Such decisionst could be viewed like a feasibility study on any business to needed to be undertaken.

The augurs have always been regarded as a special group of priests within a larger group of soothsayers (aruspices), their work since the time of the Etruscan culture was to interpret and understand the general will of the gods. A tradition whose origin goes back to the early days of the founding of Rome, some historians such as Squadrilli (1961) [27] and Beard (1998) [1] place this tradition at the time of Romulus. In more recent times, the augurs are often associated with interpretating the flight of birds, carrying a stick with a bent tip like an umbrella called a "lituum", whose function was to limit the number of birds seen in sky so that their behavior could be observed with care. This has been considered a mere superstition, which ignores birds remarkable sensitivity to environmental factors. Few people however, remember that this *lituum* was also used as a divining rod, and therefore it could be argued the art of dowsing was known to the Romans since the Etruscan times. At the very least, this class of soothsayers could have been used to search for hot springs in the Laško area to precisely locate the baths.

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Dowsing has traditionally been used to detect geopathic stress, although some alternative methods including Vegetative Resonance Testing have been discussed by Dubrov[22]. In modern times, dowsing is not fully accepted by mainstream science, despite some research that has demonstrated its effectiveness to find water by Betz[2,3]. One of our collaborators revived the augurs ancient tradition by using a pair of copper dowsing rods. In the ancient Roman palace Felix Romuliana, Serbia, they obtained many successes which were later confirmed by our equipment in approximately 80% of cases (Debertolis and Zivić, 2015) [15]. In particular, they discovered the presence of underground water at a number of locations within the palace in the form of "blind springs", where a given number of water veins rise vertically below the surface without actually emerging above ground. Of interest is that at these same positions our research collaborator found such 'springs' our equipment (ultra-sensitive microphones) detected the presence of infrasounds believed to originate from the movement of such underground water.

In medical science it is well known that in the human hands and chest exist vibratory receptors, the so-called Meissner's sensors, which are capable of detecting non-audible vibrations[5]. It is evident that personal experience and training was important for the ancient augurs to understand where the best vibrations existed to place a military camp, a spa or palace. In modern times, such studies are being rediscovered in the field of bio-architecture that takes into account characteristics of the location and surrounding environment before any construction takes place, in order to avoid the onset of geopathic stress for future occupants.

It is clear that just as in ancient Romans times, where the thermal baths were frequented by the nobility and kings of that time, their present day location inside the hotel remains unchanged and in modern times, anyone can benefit from their wellbeing properties.

(*) 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 properties of ancient sites and temples throughout Europe and Asia (www.sbresearchgoup.eu).

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