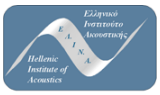

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ACOUSTIC POTTERIES IN SOUTHERN ALBANIA

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Abstract
In the summer 2007, the author had the opportunity to participate to an archaeological campaign in the village of Voskopojë, near Korçë, in the South of Albania. Located on the merchant trail that linked Venice, Dürres and Istanbul in the XVIIth et XVIIIth centuries, Voskopojë was then a Christian stronghold in a Moslem environment, and one of the most flourishing cities of the Balkans, with 26 orthodox churches, an academy and the first printing house of the Balkans. Our study mainly concerns the St-Elias church from 1751, with some more ancient parts. Its specificity is a wooden ceiling, unique for church in this area. Notwithstanding, 35 acoustic potteries are arranged all around the church, most of them just below the ceiling. We will relate our attempt to measure these potteries, as well as the acoustics of the church. We will gives some more examples of acoustic potteries from the 4 surviving neighbouring churches, as well as from a mosque and a Koranic school in Berat, the nearest city west of Voskopojë on the ancient trail.

Keywords
Acoustic potteries, architectural acoustics, Eastern Europe.

1. Introduction

In 2007, an archaeological campaign in Southern Albania was organized by the association *Patrimoine Sans Frontières*. It consisted in a study on the acoustic potteries of the St-Elias church, a monument listed as "historical centre" by the Albanian government. St-Elias, or St-Elijah, stands in the locality of Voskopojë, at 1221m of altitude in the west of Korçë. Located on the merchant trail that connected Venice to Istanbul in the XVIIth and XVIIIth centuries, what is now a small village was at the time one of most flourishing cities of the Balkans, with 26 churches of which only five remain today. St-Elias church is dated back to 1751, but certain parts probably are more ancient.
The major part of the study consisted in the cartography and acoustical measurements of hundreds of potteries in Voskopojë, both in the St Elias and St Michel churches, but also in the town of Berat, located 50km to the west on the same trail, in the Tekke of the Dervishes and in the Leaden Mosque. The study also included measurements of reverberation times when possible (St Elias, and Tekke), but this is not related in the present paper.

2. Acoustic potteries and Helmholtz resonators

2.1 Acoustics potteries

Acoustic potteries are usually clay potteries - but glass bottles are sometimes reported, as in the Melleray Abbey in Brittany - that the builders of the Middle Ages embedded in the walls of the churches. Only the opening of these potteries remains apparent, all one thus sees is a hole, which for an uninformed eye generally remains unperceived, or confounded with a putlog-hole for assembling the scaffolding. The potteries have various forms, due to the fact that they very often were reemployment materials, probably after an initial domestic use.

Figure 1 – Different forms of potteries [1]

Many theories exist on the destination of these potteries: heating devices (potteries with coal residues were discovered in Notre Dame of Calais, but this an isolated case); tidies (in dwelling houses, but not in churches considering the height of their implementation); draining devices (humidity accumulates by condensation inside the vases, thus cleansing the walls); or devices for reduction the weight of the vaults (considering the weak weight of the potteries). But the acoustic theory has the favour of tradition, as was explained in the first paper of this session [2]: indeed, though it does not constitute a reasonable evidence, the number of vases grows with the volume of the buildings, and a few medieval texts explicitly associate them with an acoustic intention [1].

2.2 Some theoretical elements

Acoustic vases are nothing else but resonators, that is, they can be modelled as a mass-spring system with some absorption. Literature has listed four acoustical effects that can be attributed to them, and their respective importance depends on the number, sizes, attenuation, and disposition of the resonators [3].

Reverberation: the fictitious piston in the neck emits a sound at the frequency of resonance of the resonator, whose amplitude decreases exponentially.

Diffusion: part of the incident energy is re-emitted by the fictitious piston of the neck according to the radiation laws for a vibrating piston in an infinite screen. Thus, at low frequencies with respect to the size of the neck, energy is returned by the resonator as a wave emitted in all directions (point source).

Absorption: resonators do not restore all the energy they receive, since a part is lost due to friction, and viscosity of air. This is the main use of resonators in architectural acoustics.

Amplification: this is the effect to which the chroniclers of the Middle Ages refer (e.g. Baudoin: "the vases doubled or tripled the range of the voice of the preacher…", see [1]). However, this effect is not perceptible beyond a certain distance, and it remains an open question whether a very large number of potteries laid out in a certain arrangement could have such an effect due to coherent reinforcement. Besides, the name Helmholtz resonator does imply a resonance frequency, with marked amplification in its vicinity [3].

2.3 Measuring resonators

The Laboratory of Aerodynamic Studies in Poitiers loaned us its measurement equipment. It consists in an electret microphone mounted on a telescopic pole (initially a carbon fibre fishing cane) and provided with a metal claw to facilitate positioning in front of the potteries usually located high above ground level. An external source, a clapper or a rattle or just background noise, excite the resonator, whose response is easily measured by the microphone positioned just in front of its opening (Figure 2).

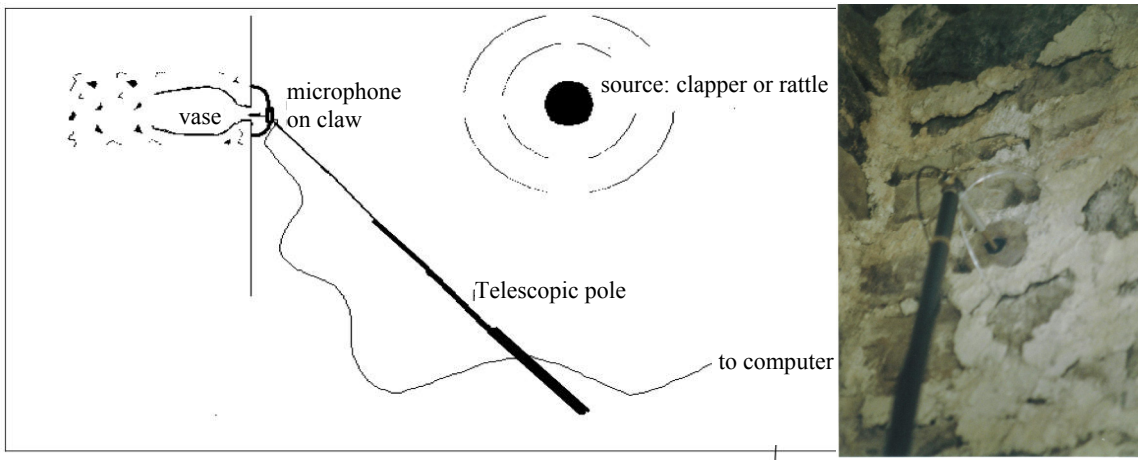

Fig. 2. The measurement system

The equipment comes with adapted software for calculating short-time FFT and displaying the results in real-time. Figure 3 presents a typical display, with the time signal in the upper left, the spectrogram in the lower left, and the spectrum on the right. Notice that the formants, corresponding to the resonances of the resonator, are easily seen on

the spectrogram, and their centre frequency is easily measured on the spectrum. The frequency of the first maximum usually is the Helmholtz resonance frequency.

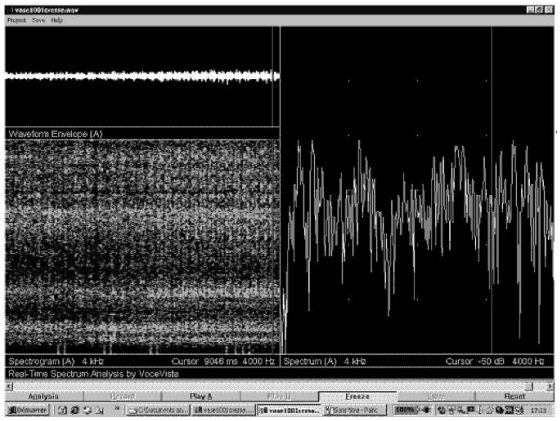

Figure 3 – Measurement display

3. Saint Elias Church

St-Elias is one of the five remaining churches at Voskopojë, but unfortunately is the most dilapidated. Its particularity is a wooden ceiling, that can be seen on the Figure 4, but had fallen to the floor during the winter 2007, just before our campaign.

Figure 4 –St Elias ceiling before campaign (left) and interior during campaign (right)

In this church, 35 potteries have been reported. They are located all around the church, some 1m below the ceiling. However, when we tried to measure them, we discovered that all were broken (Figure 5), but two.

Figure 5 – Some examples of pottery found in St Elias

4. Other churches in Voskopojë

A few hundred yards away from St Elias is St Michael church, where we discovered 29 potteries, of which we measured the responses. There are probably more potteries, because a characteristic of this church is that the potteries are hidden under a thick layer of coating (ca. 1"), that supports the frescos. Only where the coating is fallen off could we find potteries (Figure 6).

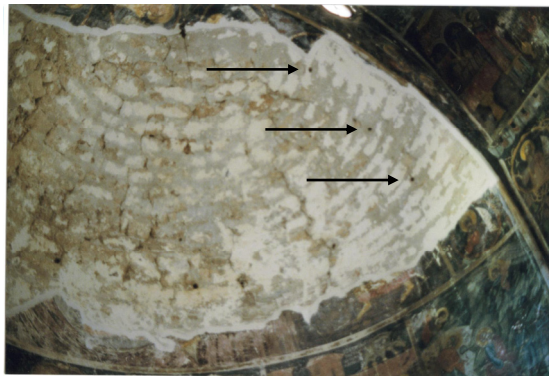

Figure 6 – The apse of St Michael, with arrows pointing to potteries

But acoustics potteries are not only found in churches in Voskopojë. They are also present in the church towers, just above the bells (Figure 7), where 4 potteries are arranged regularly in the cupola that surmounts the bells. This finding is in favour of an acoustical interpretation of these devices [2].

Unfortunately, we were not able to find out if the potteries are orientated according to the cardinal points.

Figure 7 – Pottery located in church towers (arrows)

5. Leaden Mosque and Koranic school in Berat

The Leaden Mosque in Berat is exceptional for potteries [4], not so much due to their number (303 in the dome and 55 on the walls) as due to their disposition (Figure 8). Due to their height (up to 12m) and time constraints, we measured only a sample of 47 vases with great difficulty.

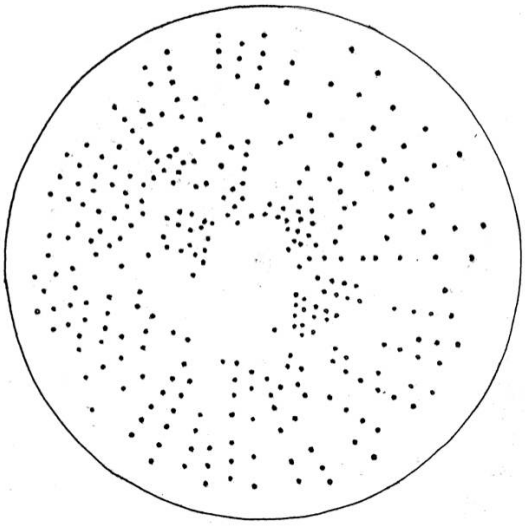

Figure 8 – Pottery disposition in the dome of Leaden Mosque (courtesy of IMT Berat)

The Alveti Tekke, is the old dervish school, located in the Islamic Centre which is now partly used by the Institute of Monuments and Culture in Berat. Its walls contain 53 potteries, but tapping on the walls reveals that more potteries could exist: it sometimes sounds hollow. Figure 9 shows the positions of some of the potteries; some of them were until unknown (nr 2, see [4]).

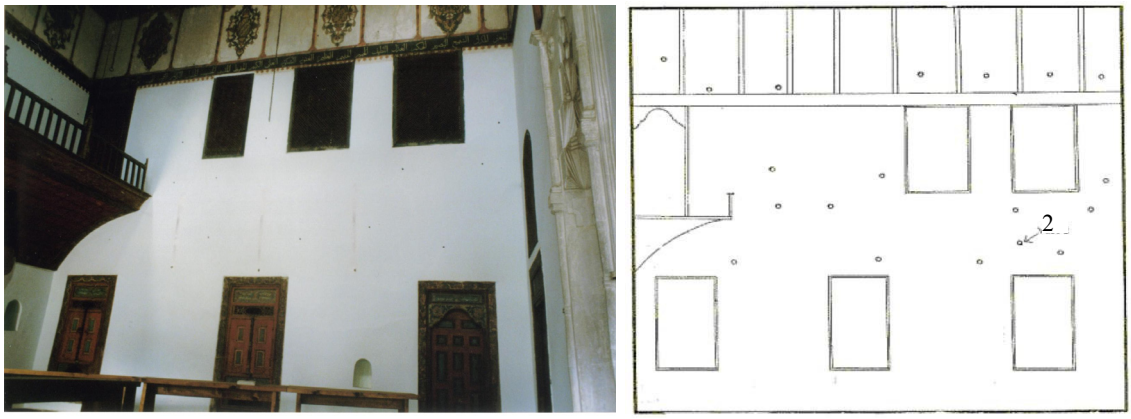

Figure 9 – Pottery disposition in the Alveti Tekke

6. Conclusion

This measurement campaign of acoustic potteries in Southern Albania raises more questions than it gives answers. First of all, it attests the use of acoustical potteries in the Balkans at a time where it had been abandoned in Western Europe. Second, none of the implementations discovered in Voskopojë can be acoustically efficient, due to the larger absorption of the wooden ceiling in St Elias, or to the presence of frescoes that originally covered the devices in St Michael. Of course, the 303 potteries in the dome of the Leaden Mosque are likely to be acoustically efficient, but it needs to be checked by proper measurements [5].
The disposition of the potteries on the dome (Figure 10) strongly suggests a symbolic interpretation for the use of acoustical potteries, as developed in [2] for Vitruvius's

echeia. This interpretation is further supported by the hiding of the devices below thick coating and painting in St Michael, or by the implementation in bell towers, open to the winds. Last but not least, very few of these devices were intact when we measured them, leaving wide-open speculations about their real use.
If they were not linked to acoustics in the mind of the builders, why then did they use them in bell towers?

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