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Preliminary Study on The Sacred, Hidden, Water Source inside the Basilica Ulpia in Roman Forum

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Abstract
Paper treats a research inserted in a wider project that aims to compare different spring-waters emerging in the area of the Roman Forum (Rome, Italy).
"In situ" and lab measurements were performed inside the Basilica Ulpia in three different seasonal periods and a monitoring of several parameters was performed for a month. Main parameters were measured basing on "Metodi analitici per la misura delle acque IRSA-CNR" from 2004, updated in 2006 [1].

Introduction
Rome area has been inhabited since prehistoric times thanks to the presence of the Tiber River, its tributaries and several sources therein. Many of the sources were used for drinking while others were used for therapeutic purposes. Some of them were sacralised because rich in minerals or gases (such as sulfur waters) and temples were built were they spring [2].
In fig.1 a map of such water-sources is shown: the green and red flags refer to actually accessible and not accessible sources respectively; the blue ones indicate two standpipes closed in the considered area.

Figure 1 – Water sources survived in the area of Roman Forum

1: Juturnae
2: Romulus Temple,
3: Lapis Niger
4: Mamertino Jail (Tullianum)
5: Basilica Ulpia,
6: Valentini Palace **(**Small Baths)
7: Valentini Palace (the well)
8-9: standpipes
10: Meta Sudans
11-12: Ancient sources

Our research project foresees the comparison of the actually accessible water-sources and the one (n. 5) located inside the Basilica Ulpia is object of the present paper.

The Basilica Ulpia is located inside the “Foro di Traiano” [3,4], i.e. the last constructed by Romans, completed in 112-113 A.C.. The Forum's area was obtained by cutting the slopes of the Quirinal, and the cost of colossal work was covered by the booty from the conquest of Dacia, present-day Romania. The decorations of the entire complex, and in particular the story carved on the Traianum column, celebrate this glorious military enterprise.
The Basilica's structure raises on three steps and the facade was at least partially open with a grooved colonnade, of Corinthian order, in yellow marble.
The inside was divided into three naves separated by columns of gray granite. A second floor, with marmor carystium columns, and perhaps even a third overlap the nave.
Today only the central stump is visible, with the western apse hidden beneath the Imperial Forum and the eastern under the Magnanapoli staircase and the adjacent buildings.
The Basilica's area was excavated in the early nineteenth century, during the Napoleonic occupation of Rome. The western end of the nave up to the attack of the apse was dug in the thirties and an eastern apse area has been brought to light from excavations conducted by the Superintendence of Cultural Heritage of Rome in recent years under the palazzo Roccagiovine.
The gushing point, from us considered, is placed outside the ancient Basilica, on the left side beyond the wall of the apse.

Experimental

Instruments and Reagents

Ion-Cromatograph Metrohm 761 equipped with Dionex Ionpac AS15 column.
Spectrophotometer Lambda 15 UV/Vis from Perkin Elmer, Usa
TOC Total Organic Carbon Analyzer TOC-Vcsh from Shimadzu, Japan.
Titrator, Digital Burette Model 233 from Amel Instruments, Italy
Phmeter 338 and conductivimeter 160, from Amel Instruments, Italy
Electrodes and Data-Loggers from Vernier, USA
Multiparametric HD2156.2 with electrodes from Deltaohm, Italy
Termostatic Oven mod M70 from Fl. Galli srl., Italy
Muffle model 1001 from Gefran, Italy
Peristaltic pump sp311 from Velp Scientifica, Italy
Certified standard solution from MERCK and FLUKA
All the other reagents, ultrapure, from MERCK and CARLO ERBA

Methods

“In situ” measurements

Water gushes out from the wall of a niche that, in turn, was hosted inside a big tub that occupies most of the room. The gush is of few millimeters making impossible a direct measure and sampling; so, a dyke was constructed, using bricks enticed with mortar to confine water inside the niche itself. The level inside the weir was anyway not sufficient for our aims and we pumped it in a bucket where all measures and sampling were done as well as the monitoring. For such reason “in situ” measurements were performed only on September 2015.

“In lab” measurements

Most of the measurements, as above said, were performed according to IRSA methods while the determination of the soluble salts content we referred to ASTM D4327-11 [5].

Monitoring

Temperature, pH, conductivity, Redox Potential (ORP), nitrate, oxygen were continuously measured on 2015 from November 17 to December 17; thermo-hygrometric parameters (Temperature and Relative Humidity) were also measured in the room hosting the niche [6]. As above said, water was pumped from the dyke into the bucket; the flux of the peristaltic pump was optimised in order to have the minimum needed level of water inside the dyke.

Results

"In situ" measurements

On September 2015 Temperature, pH and Conductivity resulted respectively 17.9 ºC, 8.4 and 951 µS.

"In lab" measurements

Table 1 lists some of the parameters measured in laboratory on the water sampled in three seasonal periods. All parameters varies significantly but in the first campaign (March) the water was surely polluted because water and mud present in the big tub had entered in the niche. In the successive sampling campaigns sampling was done inside the bucket were water was pumped from the dyke's floor that was accurately cleaned previously; so, the differences between data acquired on May and September are analytically significant. The lower content of carbonate and bicarbonate is congruent with the measured lower pH.

Table 1 – Main data obtained in the analyses of the water spring in three different seasonal periods.

	pH	**Λ**	**ORP**	**$HCO_3^- + CO_3^{2-}$**	**TOC**
		µS	**mV**	**ppm**	**ppb**
March	7.53±0.02	573±14	270± 13	--	
May	7.64±0.09	822±12	177± 12	162±3*	
September	8.00±0.01	951±9	-	652±12*, 642±12**	751

* anions-cations balance, ** titrimetric

In fig. 2 the soluble salts content is reported as concentration (ppm) of the single ions. It is evident a higher concentration for September. Data are congruent with the other measurements performed in laboratory; in fact a lower conductivity results for May

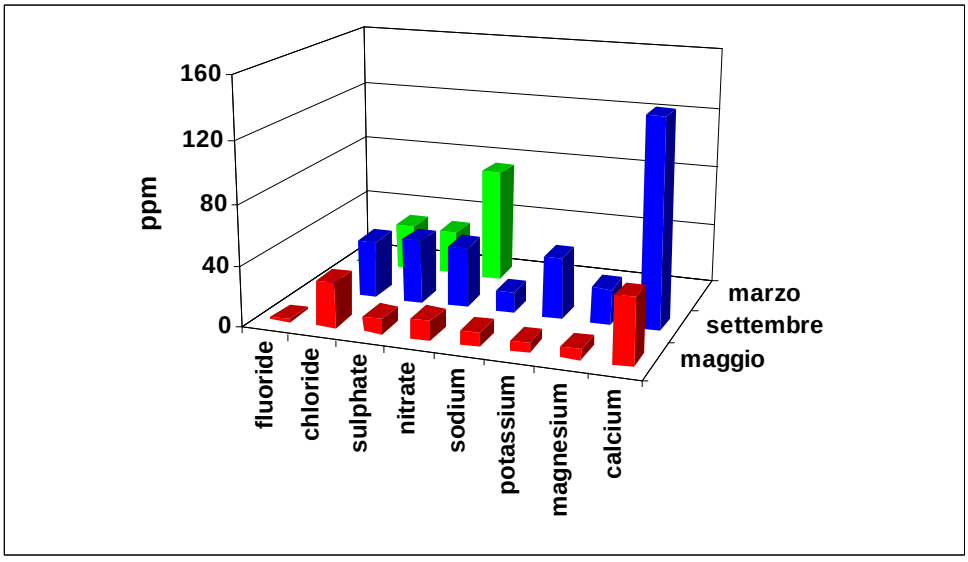

Figure 2 – Soluble salts content in the waters sampled in the three campaigns

The content of organic matter was measured by Total Organic Carbon (see Table 1) and by the measure of Volatile Organic Compounds (VOCs) that resulted almost absent with the exception of chloroform (most abundant), benzene and trichloroetilene that, anyway are below the law's limits for all kind of water. A further evaluation was done by UV-vis spectrophotometry. No signals were detected in the visible zone, evidencing the absence of coloured substances; on the contrary, a broad low band in the UV zone (254-300 nm) evidence the probable presence of some organic compounds in traces: compounds released by sediments, phenolic compounds and chlorobenzene (agreeing to VOC analyses), colloids.

Monitoring

Fig. 3 evidences the expected insulation of the room hosting the water source, the microclimate Temperature follows the macroclimate one but with highly smoothed circadian cycles and with a delay that results in 7-8 hours. The Temperature of water follows both the micro- and macro-climate with values always higher compared to the first. As it regards all the others measured parameters, we observed: a slight increase of pH (from 7.62 to 7.84), an enough consistent increase of conductivity (from 951 to 1170 µS), a significant swing of the ORP, nitrate and oxygen remained almost constant with median values equal to 47 and 5.5 ppm respectively. Besides the already cited correlation between the water and microclimate Temperature, water Temperature and pH also result correlated. An infiltration was revealed in the tenth day of monitoring that provoked a sudden significant increase of pH and a slight decrease of ORP and conductivity.

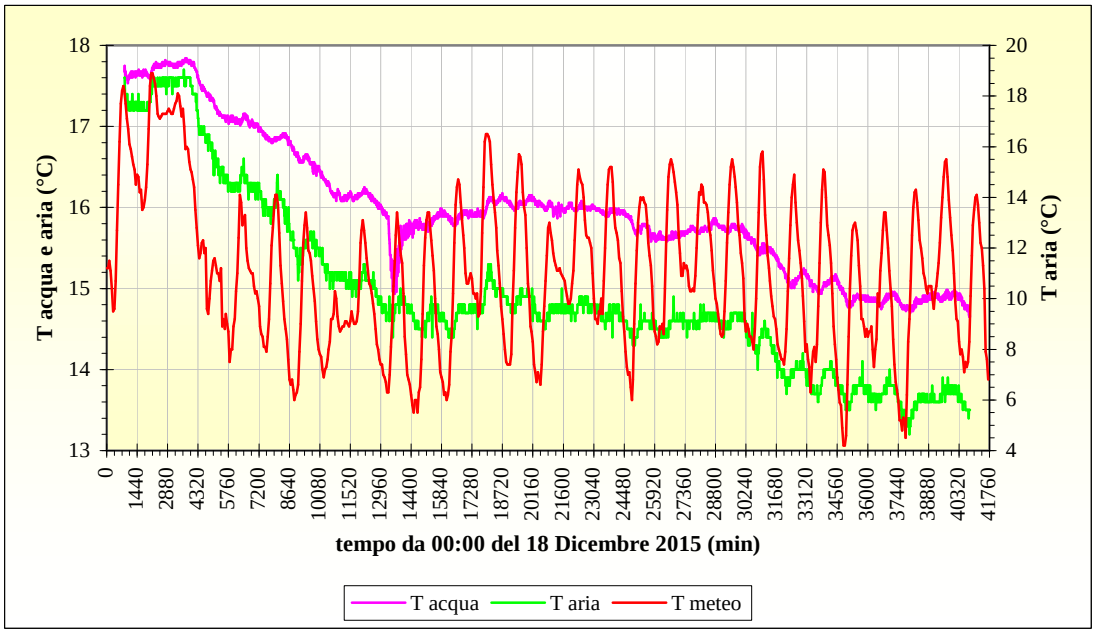

Figure 3 – Correlation between the Temperature of water with microclimate and macroclimate ones during the continuous monitoring of the water source

Conclusions

The research work allowed to characterise the water gushing inside the Basilica Ulpia and will be inserted in a wider project aiming to compare all the up-today accessible water-sources emerging in the area of the Roman Forum. Our sampling area is very close to the remains of the tomb of Caio Poplicio Bibulo, from which one can assume the re-discovery of the Porta Fontinalis mentioned by historians.

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