Investigation on the constructive techniques of the Concordia Temple (Agrigento) through the GPR method

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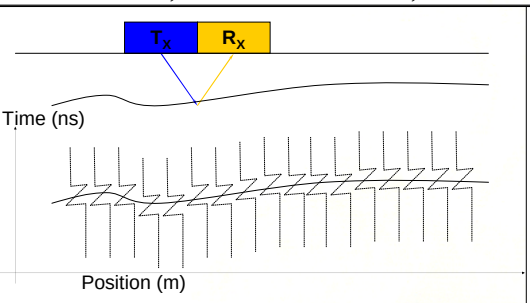


Pic. 1: Operation's model of GPR.

How GPR method works?

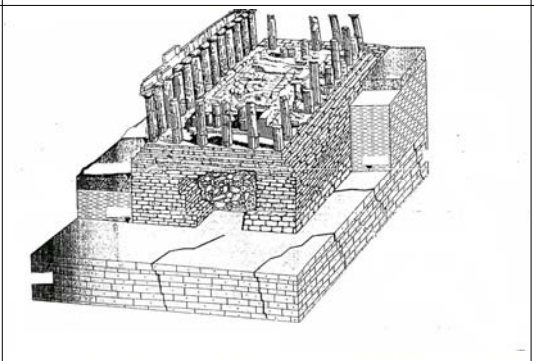
Currently non-destructive ground-surface geophysical prospecting methods, which involve detailed physical and geometrical reconstruction of subsurface structures, are increasingly used for the investigation of archaeological sites. The GPR (Ground Penetrating or Probing Radar) method works through the emission of short electromagnetic impulses that are reflected back every time they meet an abrupt change in the electromagnetic properties (due to objects or interfaces between layers). The result of a GPR survey is a 2D or a 3D image of the subsurface, in terms of two-way travel times and antennas positions (see Pic.1). In some GPR systems, sayings monostatic, the receiver (Rx) and transmitter (Tx) antennas coincide, whilst in the bistatic systems the antennas are separated. In the reflection mode, the data are collected moving the antennas along a profile, and acquiring the traces at a specific space interval.

Pic. 2: PulsEkko 1000: instrument used for the geophysical survey.

The Temple

The scope of the GPR prospecting was the investigation of the foundations' geometry of the Concordia Temple located near Agrigento (Sicily, Italy).

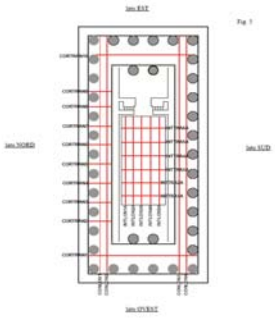
The setting of this temple is unique in the world; ratios are simple and proportions are perfect. Erected around 430 B.C., it is 19,75 by 42,23 m, slightly larger than a double square. It covers an area of 843,38 m² and has a height of 13,481 m. The cell is preceded by a simple antechamber (*pronaos* 5,110 by 7,650 m) with two columns and is followed by a back porch (*opistodomos* 4,720 by 7,650 m) where the treasure, votive gifts and the archives of the temple were kept. The elegant and airy columnade, according to classical models, has 6 columns by 13; every column, 6,75 m high, consists of 4 drums and has 20 sharp-edged flutes. The temple was named by the historian Fazello (1490- 1570), who found a Latin inscription in the vicinities, not having any relationship with the building. In 597 A.D., it was converted into a Christian basilica by the bishop Gregorio.



Pic. 3: Reconstructive hypothesis of the foundations before carrying out the prospectings.

Data acquisition

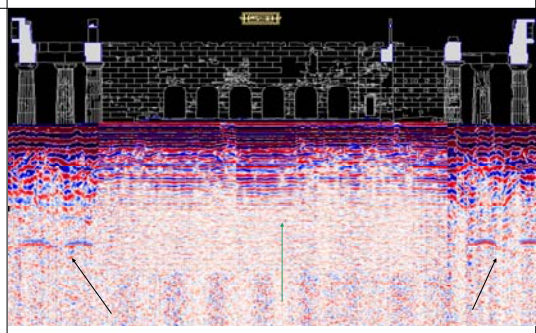
The measures have been executed collected placing the antennas Tx and Rx to one prefixed distance (0,5 m), maintaining them perpendicular to the direction of the profile (PR-BD, *perpendicular broadside*). To obtain a good vertical resolution and, at the same time, a good signal penetration, the profiles have been acquired mostly with the 225 MHz antennas. In order to avoid spatial aliasing and, therefore, a false image of not-horizontal reflectors, the data have been acquired with a sampling interval of 0,10 m (***in** step mode*),. The traces have been collected with a stacking equal to 16 and a time window of 100 ns. During the prospecting they have been acquired a total of 261,30 m GPR data and, in particular, in the external part they have been collected 4 longitudinal profiles along the greater axis of the temple and 10 cross-sectional profiles: 2 along the minor axis of the temple and 8 short profiles along the North side; whilst in the inner part of the temple they have been collected 5 longitudinal profiles parallels to the greater axis of the temple, and 6 cross-sectional profiles parallels to the minor one.



Pic. 4: In red are featured the longitudinal and cross-sectional profiles acquired.

Results

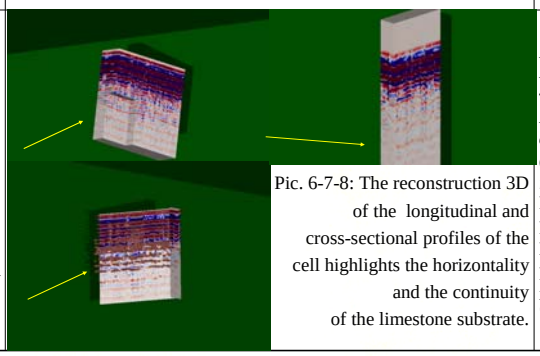
Data have been interpreted on the basis of the comparison of several longitudinal and transversal sections, and after created a 3D model of the inner longitudinal sections of the temple. Such an interpretation has led us to the conclusion that the Concordia Temple has been built up through two various constructive techniques. Is clear a first layer that starts from the stamping plan and it extends in depth for approximately 2,8 m: it is constituted by orthogonal limestone blocks partially cemented between them (but sometimes not perfectly), creating the paving of the temple. Note that, in the most superficial part this layer presents some graves and reservoirs. A second layer shows an alternated structure of kerbs constituted by aligned blocks and separated by empty (or partially filled up from bringing back-soil) spaces. This last layer is present along all the northern side of the temple; along the southern side, instead, this structure with kerbs is implemented by the substrate. In the middle of the temple, in correspondence of the cell, the kerbs come replaced entirely the substrate.



Pic. 5: Section of the foundations, along the greater axis of the temple: the black arrows indicate the kerbs, while the green arrow the horizontal natural substrate.

Conclusions

In conclusion, it turns out evident that the techniques of construction used in the Concordia Temple are mixed; in fact the temple, in part, founds itself on artificial substractions (the kerbs) and in part on the natural full of rocks spur on which it rises. Similar foundations are present in some temples of the Archaeological Valley near Agrigento (Vulcan's Temple or Demeter's Temple) and of Sicily, like for example in Selinunte (Temple E). The non-destructive remote sensing, with a Ground Penetrating Radar system, allows to probe location, depth, size and general composition of the buried structures. In particular, the results of this study show that GPR is very effective in investigating the foundation's geometry not only of an ancient temple, but also of any kind of archaeological buildings, in which it is impossible to apply destroyed survey.



Pic. 6-7-8: The reconstruction 3D of the longitudinal and cross-sectional profiles of the cell highlights the horizontality and the continuity of the limestone substrate.

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