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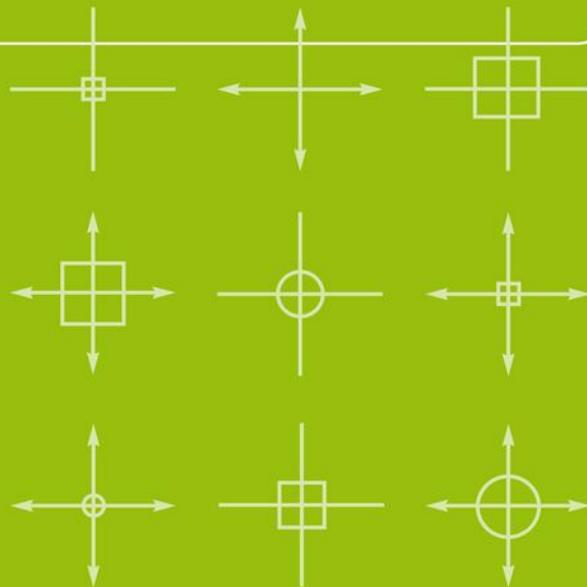
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Subject to modifications,

Vienna, 2012

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Winner of the  
3rd Vienna Archaeology and  
Cultural Heritage Poster Award  
2011

## Carved stone and web geography

### A full digital approach to localization and information handling for rupestrian monuments

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**Abstract:** The rupestrian settlements have always been a highly suggestive and interesting subjects for archaeologists and artistry scholars. In many rupestrian sites, one of the main problem has always been the clear reading of the shape of the cave and the creation of relationship between a certain variety of information and graphical and textual elements coming from the state of knowledge about that structure. Often the place where the monument is situated can be quite difficult to find and to access, even in the case of some well-known sites it can be hard to find their exact position when moving in their surroundings. A possible answer to this complex problem, can come from a multimedia digital solution, combining the web geographic resources and the use of virtual panoramic images capable to create links to a wide range of data. In the proposed case study, the complex settlements in the Massafra area, near Taranto in Puglia – Italy, has been taken as a test to build a system based on Google Earth paths and waypoint tracing combined with panoramic images built using standard photographic cameras and a dedicated tripod head. The overall result is linked to a system of connections capable to establish a complete network between the location of the monument and all the available information about architecture, art and history related to it. In specific, the Church of San Simine and Sant'Angelo are the core of the research, while a partially rupestrian architecture was studied in the town center of Massafra. As shown, this work has born from the wish to deal the studied projects in a manner capable to develop a method to establish a different technical methodology which can be applied also in other architectonic cases and can be expanded using the latest multimedia technologies.

**Keywords:** Rupestrian, Panoramic, Google Earth, Web Geography, Digital Imaging.

#### Step one: the sites

The territory of Puglia, Italy, involves 13 municipalities (Gravina in Puglia, Altamura, Santeramo in Colle, Laterza, Ginosa, Castellaneta, Palagianello, Mottola, Massafra, Crispiano, Statte, Montemesola, Grottaglie) where in each one it is possible to find host signs of "Rupestrian" civilization.

In the proposed case study, the surroundings of Massafra, near to Taranto in Puglia, Italy, is an area where many rupestrian sites are placed. Almost all these settlements took place between the tenth and thirteenth century and they are located in wide canyons called "gravine".

Therefore, this area is the cradle of civilization that knew how to use rocky gorges as homes, work environments and worship. These canyons were offering an easy way of digging into the rock, because of

their geomorphological construction composed from crumbly sandstone, as well an easily defendable position against all eventual external threats.



Fig. 1 – Example of gps tracking.

Without having an appropriate knowledge of the territory, it is very complicated to find these sites and to reach them, because of their strategic position and centuries of neglect. These two reasons can mean a discouraging fact even for people interested in rupestrian settlements and also can be considered as a negative influence upon the tourism. It expresses a lost chance to visit and to study some rupestrian jewel – like of the Byzantine age like the churches of Sant'Angelo in Mottola or San Simine in Pancrazio.

### The church of Sant'Angelo (Mottola, Taranto, Italy)

The church of Sant'Angelo has a rare structure, it is composed of two underground spaces overlaid with a similar planimetric plan: the upper floor as well as the lower floor is divided into three aisles ending in apses with that one difference that the lower floor was used as a burial area (similar examples were found in Asia Minor).

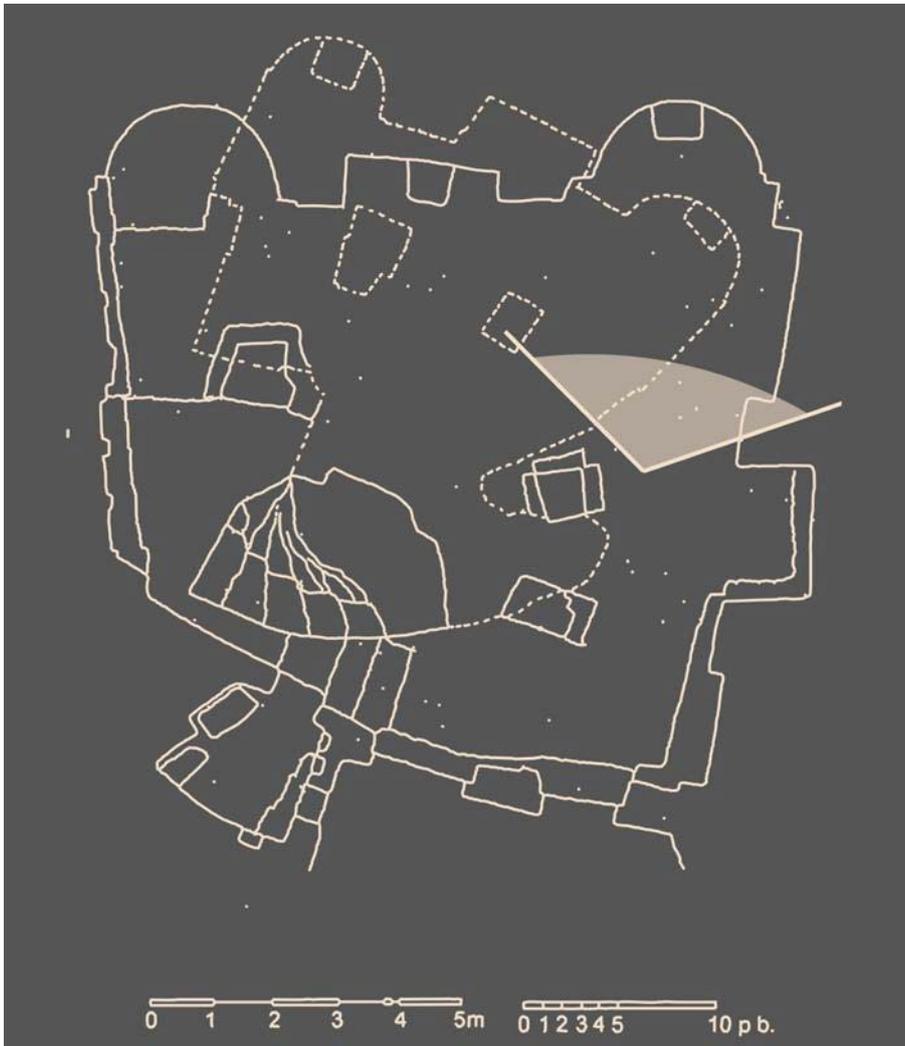


Fig. 2 – Church of Sant'Angelo: plan view.

Initially, the structure was used as a church for burials like we can see it from the repetition of the iconographic theme of Deesis.

Probably the original structure was formed by two naves and left aisle, which is situated close to the north wall and it seems it was dug later on. As shown by the architectural style that part of the church is different from all the rest. In the thirteenth century the stairway leading to the Crypt was excavated and was used for burial rites.

The church is liturgically oriented with apses directed to the East and with aisles divided by three monoliths pillars. There are barely visible traces of the original iconostasis on the floor which was probably destroyed during the construction of the Crypt.

Outside, the church has a large pronaos that was covered with roofing tiles found during the excavations in 1972.

#### *The upper floor*

The upper floor is the most ancient. It was built in the twelfth century. All the frescoes of this church are seriously damaged: their bad condition is specially caused by the air pollution, water infiltration and some acts of vandalism. All the frescoes are from the thirteenth-fourteenth century. It is possible to suppose that there had existed many other older frescoes but unfortunately during the years they have become lost.

On the right of the upper floor there is a painting of saint Bishop. The painting is palimpsest and includes the ruins of Madonna with Jesus sitting on the throne with an overlapping layer of a saint. On the external archivolt's side are painted two flying angels with red clothes. Close to these angels there is a fresco of St. Sylvester Pope with Mithra and pastoral.

In the second niche there is painted the scene of the Martyrdom of St. Stephen, partially destroyed during the construction works of the aisle. The following scene is the scene of Jesus Baptism which was painted in the thirteenth century. Another fresco is the palimpsest of Saints Vito and Paul. In the third arch it is barely visible St. Augustine who blesses with his right hand and in his left hand holds the pastoral.

Two Deesis are still present in the apses of the upper floor. The first Deesis is situated in the first apse and shows St. James appearing with the "*pecten iacobaeus*" on his mantle and with pilgrim's bag instead of St. John the Baptist.

In the third apse on the left side there had been the fresco of Madonna with Jesus on the throne, but in the present we can see only damaged remains of it. Close to the fresco of Madonna with Jesus on the throne there are the archangels Michael and Gabriel. Dott. Diehl made an incorrect evaluation of this fresco and swapped the figure of Madonna with the figure of Christ Pantocrator between the archangels Michael and Gabriel. On the arches of the apse there is the lion of St. Mark and the eagle of St. John which are the symbols of evangelists.

Along the left wall there are other traces of frescoes that identify: St. Margaret, St. John the Evangelist and an Angel. On the left wall near to the second entrance the figure of St. Vito is painted. On the ceiling just in front of the main entrance it is possible to see a black eagle with a book in his paws, as the symbol of John Evangelist. On the left column opposite to the main entrance there are some remains of the fresco of St. George on the horse from the late thirteenth century.

#### *The Crypt*

The down floor with a burial area is from the thirteenth century. The only two intact graves which were excavated in 1972 by Dr. Roberto Caprara, contained a skeleton of a young woman and a skeleton of a young child. On the woman's skeleton knees were placed two coins from Brindisi dating back approximately to 1265. On the child's skeleton were found two silver circles placed on his/her skull.

On the right part of rounded ceiling there is the Jesus Pantocratore fresco who is sitting on the throne and near to him there are San Basilio and San Andrea. This fresco is from fourteenth century. The area under the arch which divides the right aisle from the main one, it is possible to see the fresco of San Pietro that is holding the keys and a paper roll. Another two frescoes, again in very bad conditions, represent San Paolo and San Bartolomeo.

### The church of San Simine (Massafra, Taranto, Italy)

The church of San Simine is located upon a hill, approximately 2 km far from the town and it is impossible to see this settlement because the pine trees cut off the view. To access the church is possible through two doors of which the left one is crowned by a bezel.

The structural arrangement is for many elements archaic and therefore we can assume that the hall had been excavated earlier than the apse during the first stage of excavation between the tenth and eleventh centuries.

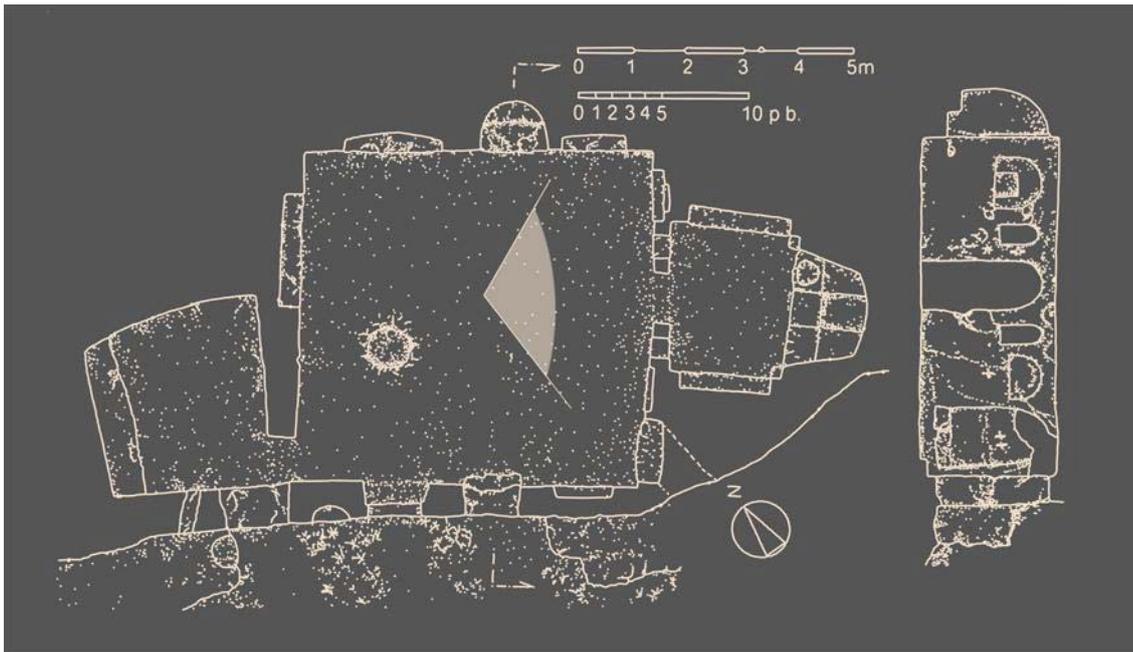


Fig. 3 – Church of San Simine: plan view.

The presbytery of the church is structured according to the forms and elements typical for a specific period (as the barrel vault), so its construction can be dated to the twelfth century. The structure consists of a hall with a rectangular niches and arches on the walls and presbytery ending in a semicircular apse.

The church has a square form with a main single hall of dimensions 6.30 m x 5, 80m with an entrance on south. Like the church of Sant' Angelo, also this church has its liturgical orientation to the east. There is another entrance at the back of the church and its existence is probably caused by an enlargement of a window.

The small raised platform holding the altar is separated from the main hall by an iconostasis which led the authors to consider this church as a church with an Oriental Rite. While in 2008 Dott. Caprara and Dott. Dell'Aquila were conducting a research on churches with iconostasis, they reached an answer that the Church of San Simine could not be a church with an Oriental Rite. Their explanation was based on the fact that many of these churches as San Simine were officiated by Latin Rite. In according with this fact and by comparisons with the church of Saints Andrew and Procopius in Monopoli (dated in 1070–1075), they were also able to set the foundation period of Church of San Simine between the late eleventh and at least early twelfth century (not before 1090 and not after 1110).

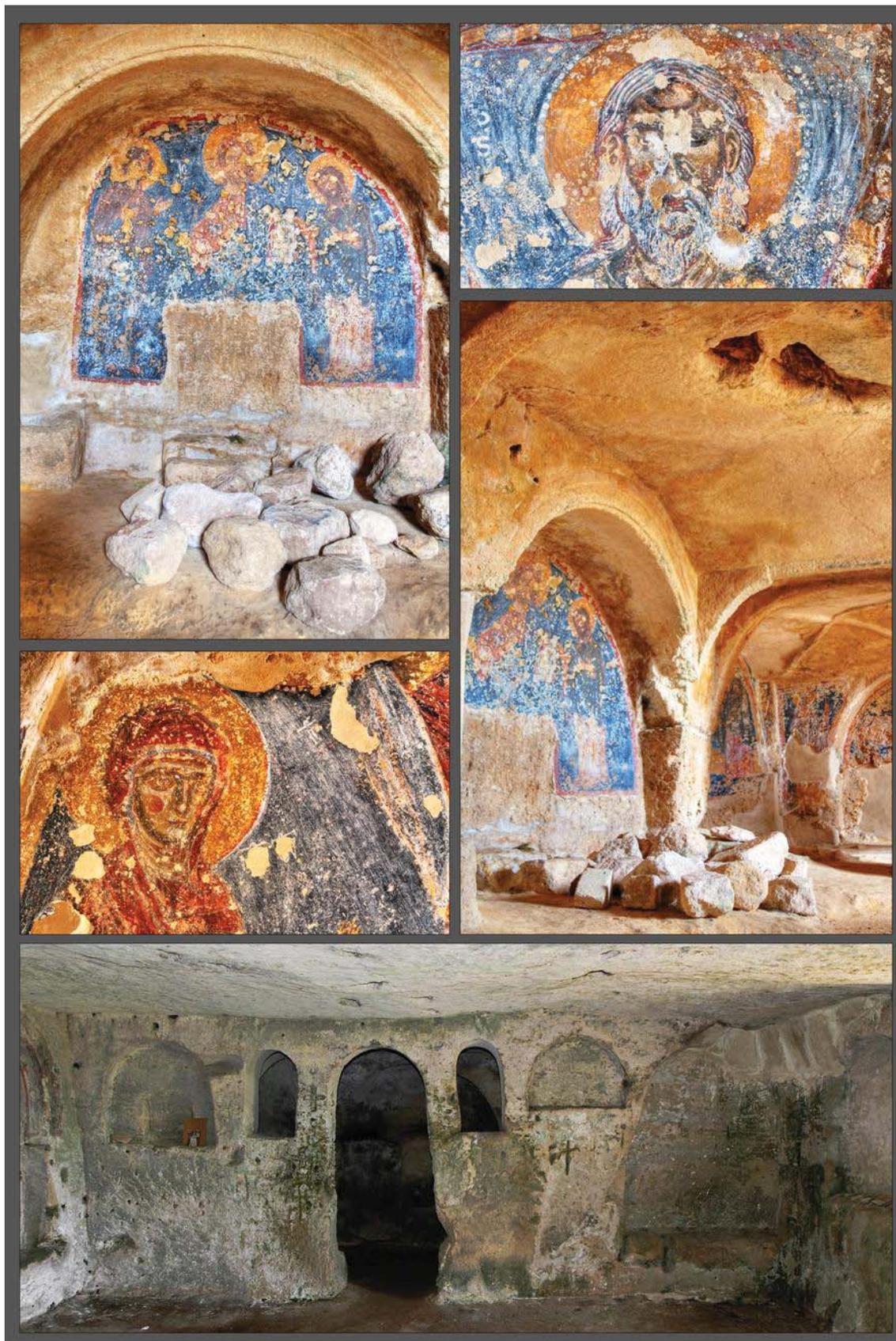


Fig. 4 – From the top left: central apse of Sant'Angelo; part of the frescos on the column of the central aisle; part of the frescos on the main apse; two of three apse on the upper floor; iconostasis in San Simine.

The peculiarity of the church of San Simine is the hall much wider than the trapezoidal small presbytery. As a consequence the iconostasis is a larger wall than the walls commonly built in other churches. It means that in addition to the door and two windows, there were also created two niches with flat bottom and rounded arch where there were icons or paintings.

On the north wall there are three niches: inside the right one, Madonna with Jesus sitting on a throne is painted, in the left one it is possible to read the remains of a fresco which shows a saint and it seems that he represents St. Jude Thaddeus.

On the west side of the church in connection with its main hall, there is a small irregular almost quadrilateral room with niches, with a small couch, with ruins of a seat. These equipments are usually interpreted as the place of a hermit's accommodation. In the context of church of San Simine, hermit's role was to guard the church. Like the church of San Simine, during the excavations executed in 1972 in the church of Sant'Angelo on its north side, were found a small pot and a dish belonging to the hermit.

### **Step two: the approach**

The purpose of this project has always been to focus on the creation of an information network regarding the rupestrian locations of Massafra area that would be extendible also for all the rest of archeological locations with about-mentioned problem of access and research.

To reach this purpose we have mainly relied on two types of technological tools:

#### **The GPS system**

The GPS system has been a fundamental element for our project. Basically, the GPS or the Global Positioning System tracking is really a powerful and innovative tool because it determines the exact location of a certain person, asset, vehicle and location.

The information is easily transmitted through certain devices such as mobile phones, GPS trackers, and computers with Internet. Any information can usually be viewed in real time on a map to help anyone to locate his/her subject easily and quickly.

An advantage of GPS tracking system is that it can work in many various ways. The most common one is when GPS devices record the position of vehicles as they make their journeys. "Some systems will store the data within the GPS tracking system itself (known as passive tracking) and some send the information to a centralized database or system via a modem within the GPS system unit on a regular basis (known as active tracking) or 2-Way GPS.

A passive GPS tracking system will monitor location and will store its data on journeys based on certain types of events. So, for example, this kind of GPS system may log data such as where the device has traveled in the past 12 hours or more.

The data stored on this kind of GPS tracking system is usually stored in internal memory or on a memory card, which can then be downloaded to a computer at a later date for analysis. In some cases the data can be sent automatically for wireless download at predetermined points/times or can be requested at specific points during the journey" ([www.eetimes.com](http://www.eetimes.com)).

As we already mentioned, we took advantage of this instrument which allowed us to mark the paths with a high level of detail and precision to reach the rupestrian settlements.

### **The 360° panoramic view**

Modern and innovative ways of 3D space presentation are the spherical 3d panoramas and virtual tours, by using the 360°x180° panoramic photo projection.

There are many kind of 3D panoramic view:

- ▶ 360° panoramic view,
- ▶ virtual panoramic view,
- ▶ spherical panoramic view,
- ▶ QTVR panoramic view,
- ▶ cubic panoramic view.

This is a new way of representation, which covers all the space around one definite point for the angle of 360° horizontally and for the angle of 180° vertically.

The 360° panoramic view of rupestrian monuments was done through the use of a "pan and tilt head" which placed on the stand, has allowed:

- ▶ The correct positioning of the camera axis for rotation in accordance with the optical zoom.
- ▶ The exact progression angle for the acquisition of frames in increments of 45° on the vertical axis and 30° horizontally.
- ▶ The realization of multi-shots (for a minimum of three for each angular increment) with a variable exposure, to create an image with high dynamic range (HDR).



Fig. 5 – Church of Sant'Angelo panoramic view.

The panorama created with all the pictures (about 200 pictures for each environment; and many poses have required more than three different exposure value) was then blended: for the first, we have identified the photos of the same group related to each pose to be blended into a single frame with HDR and, subsequently, through the use of Pano2Vr software to be defined as a single spherical image and video.

By simple use of mouse or keyboard you can view all the space around, below and above you, and plus draw nearer the things and objects or distance them. That means you can carefully examine the details or study the general concept.

The way to use the 3D panorama it's very easy. With the help of the left button you can rotate the image in the required direction and to draw the objects nearer or to distance them (zoom) it's enough to give a twiddle to the wheel on your mouse.



Fig. 6 – Church of San Simine panoramic view.

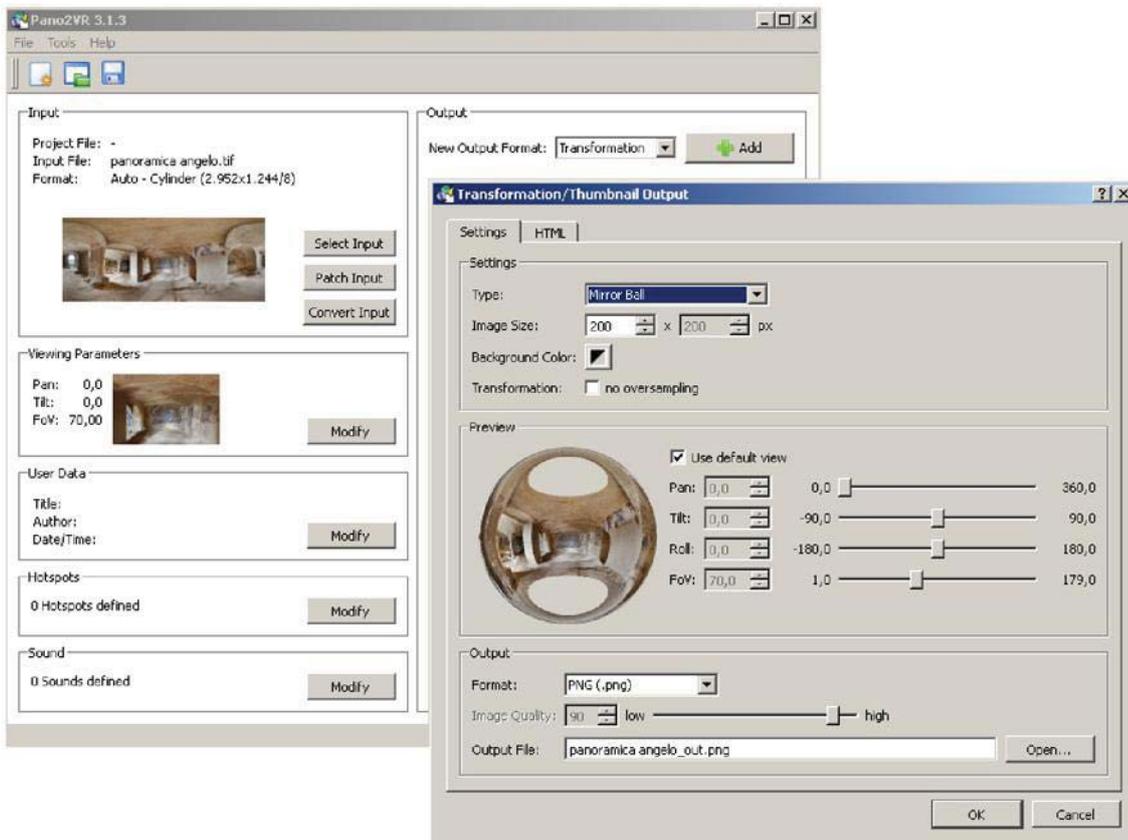


Fig. 7 – Pano2VR software's screenshot.

This type of representation not only involves a great photo of the interior but allows the navigation in such a way to facilitate the perception of the relationship between the decorative and architectural environment. All the incorporated elements of paintings shown on 360° panoramic view can be activated again via "hot spots" directly into the video by clicking on the target.

As shown, several spherical 3D panoramas can be banded together, and that's exactly the way to make a virtual tour (also known as VR tour or 360 tour). By making one single click on the pointer in the 360° panorama you're making a real journey, while moving from one panorama into another within some areas called "hot spots" that allow passage from one area to another allowing a complete virtual tour of all the interiors.

The integration between the video and a web page can be used to add new information such as references or other metric mappings and in order to give the visitors of the virtual tour a better orientation, the panorama can be supplemented with the interactive map with the "radar", which shows the view direction and the viewing angle.

In contradistinction from the video, you're not reliant on the camera movements, because the movement in space is completely under your control.

### Step three: the World Wide Web

The project had the intent to realize an information network with multiple levels of analysis and data using GPS tracking and high-resolution 360° panoramic photo.

The World Wide Web is the suitable place where to create an easy access point and at the same time to promote these archeological locations.

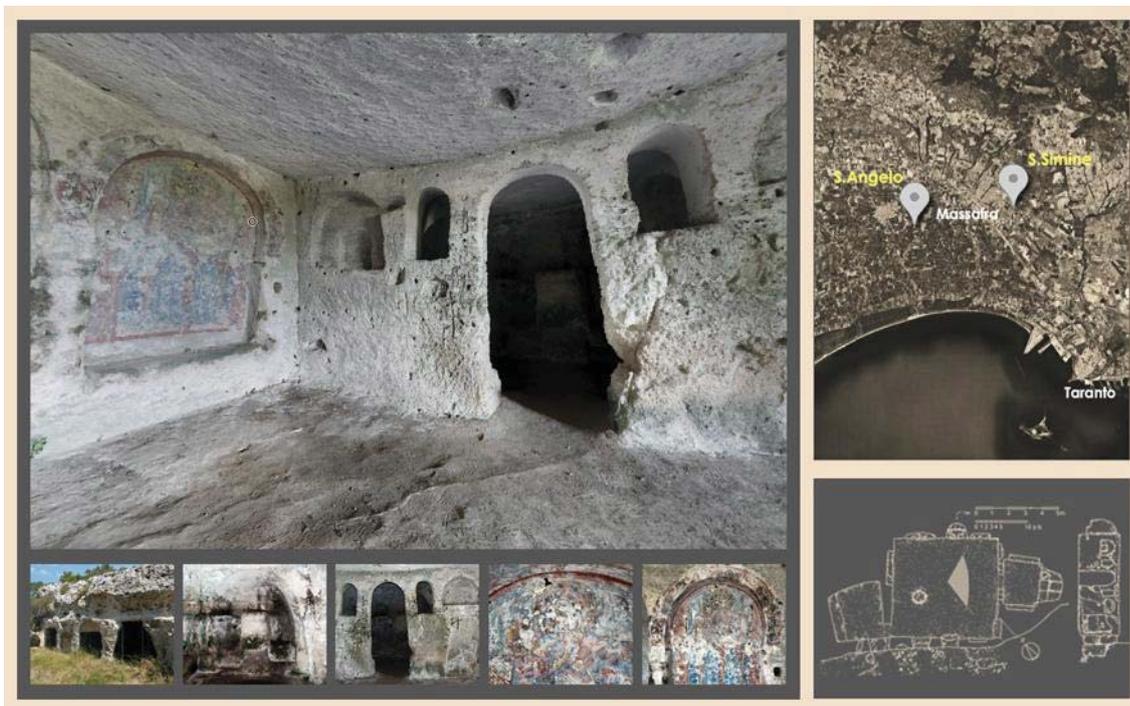


Fig. 8 – Screenshot of the testing web site [www.theamesroom.com/360.html](http://www.theamesroom.com/360.html).

It is possible to get all the information about the access routes through standard tools offered by Google Earth, Google map, etc. and also, via web-links to a html page, to reach a 360° panoramic tour of the single rupestrian monuments.

This kind of representation not only involves high quality photos but allows to the users to understand the morphological and iconographic straight lines of these sites via virtual tour.

The viewing of the spherical 360° panoramas and virtual tours doesn't require the high speed data transfer, which makes it possible to place and extensively advertise them on the Internet.

It's not necessary to install any additional programs to have an ability to view the virtual panoramas and tours. It requires only to have a web-browser, like Internet Explorer, Google Chrome or Mozilla Firefox with at least one installed plug-in as Adobe Flash, Quick Time, Java, DevalVR, Shockwawe etc.

Another important issue of the panoramic 3D presentations via World Wide Web is the twenty-four-hour availability and the possibility for the visitor to explore the object whenever he/she would like and from any place on the world.

As shown, this research was born as a wish to deal the studied projects in a manner capable to develop a method to establish a different technical approach, which can be applied also in other architectonic cases and can be expanded using the multimedia technologies.

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**CARVED STONE AND WEB GEOGRAPHY:  
A FULL DIGITAL APPROACH TO LOCALIZATION  
AND INFORMATION HANDLING FOR RUPESTRIAN MONUMENTS**  
GARMELA CRESZENZI - FILIPPO DIANSANTI - PAOLO FORMAGLIANI

**CHNT 16**  
CONFERENCE ON CULTURAL  
HERITAGE AND NEW TECHNOLOGIES  
WIEN, NOVEMBER 14-16/2011

**SITE**

The surrounding of Massafra, near Taranto in Puglia -Italy, is an area where many rupestrian sites are placed. Almost all these settlements took place between the X and XIII century, they are located in a wide canyons called "gravine".

These canyons were offering an easy way of digging into the rock, because of their geomorphological construction composed from crumbly sandstone, as well an easily defendable position against all eventual external threats.

Without having an appropriate knowledge of the territory, it is very complicated to find these sites and to reach them, because of their strategic position and centuries of neglect.

These two reasons can mean a discouraging fact even for people interested in rupestrian settlements and also can be considered as a negative influence on the tourism.

It expresses a lost chance to visit and to study some rupestrian jewel-like of the Byzantine age like the churches of Sant' Angelo in Mottola or San Simone in Pancrazio.




**A**

*places:*  
italy  
puglia  
taranto  
massafra

**APPROACH**

The purpose of this project is to focus on the creation of an information network regarding the rupestrian locations of the Massafra area that would be extendible also for all the rest of archeological locations with about-mentioned problem of access and research.

The 360° panoramic view of the rupestrian monuments was done through the use of a "pan and tilt head" which, placed on the stand, has allowed:

- 1) The correct positioning of the camera axis




for rotation in accordance with the optical zoom.

- 2) The exact progression angle for the acquisition of frames in increments of 45° on the vertical axis and 30° horizontally.
- 3) The realization of multi-shots (for a minimum of three for each angular increment) with a variable exposure, to create an image with high dynamic range (HDR).



The panorama created with all the pictures (about 200 pictures for each environment; and many poses have required more than three different exposure value) was then blended: for the first, we have identified the photos of the same group related to each pose to be blended into a single frame with HDR and, subsequently, through the use of Pano2Vr software to be defined as a single spherical image and video.

**B**

*equipment:*  
canon eos 40D  
lens: canon EF-S 17-85mm USM IS  
pan and tilt head "panosaurus"

**WEB**

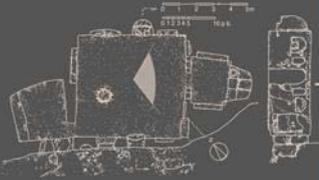


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This kind of representation not only involves high quality photos but allows to the users to understand the morphological and iconographic straight lines of these sites via virtual tour.

As shown, this research was born as a wish to deal the studied projects in a manner capable to develop a method to establish a different technical approach, which can be applied also in other architectonic cases and can be expanded using the multimedia technologies.



**C**

*link:*  
google maps  
virtual earth  
[www.thecameraroom.com/360.html](http://www.thecameraroom.com/360.html)

Fig. 9 – Poster presented at the 16 International Conference on Cultural Heritage and New Technologies – Wien 2011.