

HERACLES NEWSLETTER

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HERACLES

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CASE STUDIES

CRETE, GREECE:

1. Minoan Knossos Palace
2. Venetian coastal fortress of Koules

GUBBIO, ITALY:

3. Medieval Wall and High Town

THE MONUMENT, ITS HISTORY AND SPECIFIC RISKS/HAZARDS

P. L. Menichetti, a reknown historiographer from Gubbio, once wrote that the walls were "*a beautiful collier [...] continuously restored after wars, calamities, earthquakes and time.*" That really explains what the town walls had been looking like to

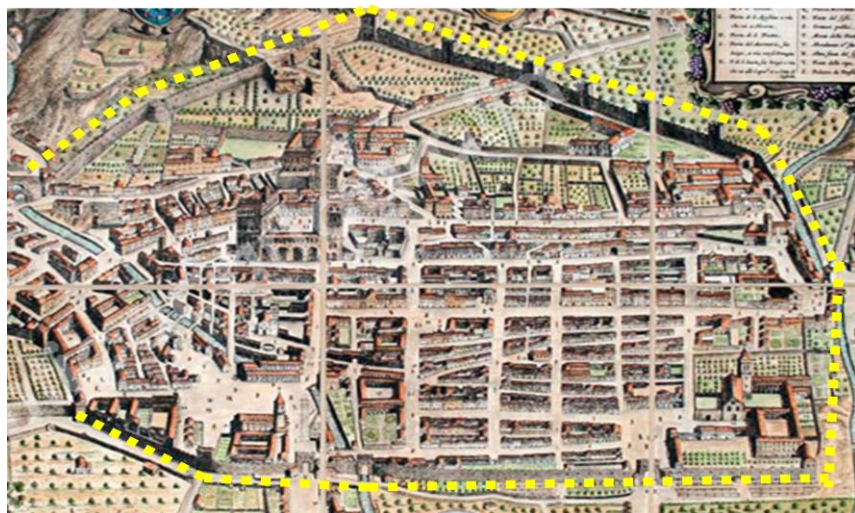
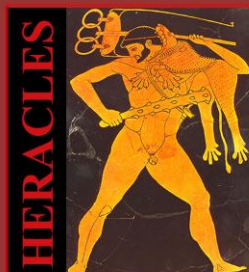


Figure 1 - Gubbio– J.Blaeu, 1663 - tracciato delle mura

each visitor arriving to Gubbio in the last eight centuries. Moreover, the town Walls had the function of “chest” or “shell” in order to protect the city against invasions, sieges and enemies raids. They represent a cyclopic structure formed over 2 millennia, continuously modified through elevations, renovations, expansions, reinforcements, modifications and demolitions too. They have a length of 2,85 kilometres, a maximum height of 12 metres, a thickness variable from 0,5 to 3 mts and variable sections. Infact, while in most parts the walls are a monolithic structure, in other parts (such as in some the test bed zones), they have a multi-level hollow core section. This in order to let the soldiers move through them and reach all the defensive towers or bastions.



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HERitage Resilience Against CLimate Events on Site

During Roman Empire (IV B.C – IV A.C), Gubbio or “IGUVIUM” was an important “Municipium” obtaining the Roman citizenship and had 7 centuries of peace and prosperity, during which the old Umbrian town became the “popular” or “artisan” part of the city, while the “residential” or “noble” part was settled in the plain. Since there were no enemies around, the ancient town walls became useless and probably partially reshaped as part of new buildings.

The end of the Roman Empire was followed by three centuries of raids by Barbarian populations.

As a consequence, the settlements in the plain were abandoned to move on the mountain where the defence was easier. The first small settlements were at first separated “vici” and raised around old pre-existing fortifications, such as the “Comizio” place or the first cathedral “San Mariano” (nearby S. John) downstream that in 921 was surrounded by walls³.

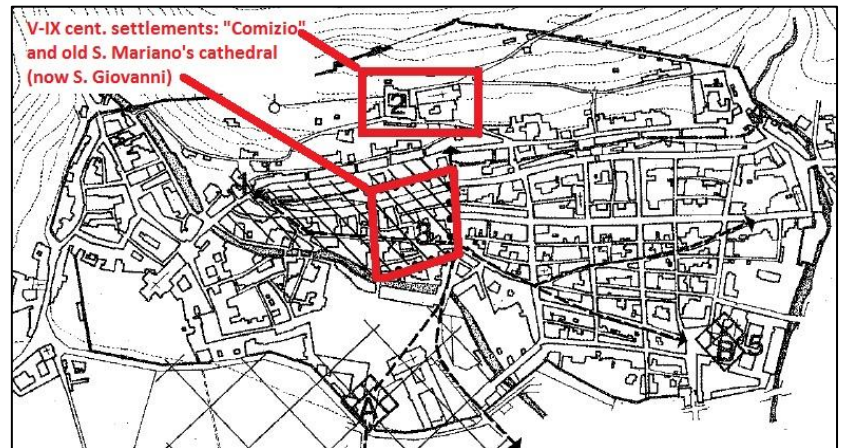


Figure 4 - "Agobio" , 5th-9th century

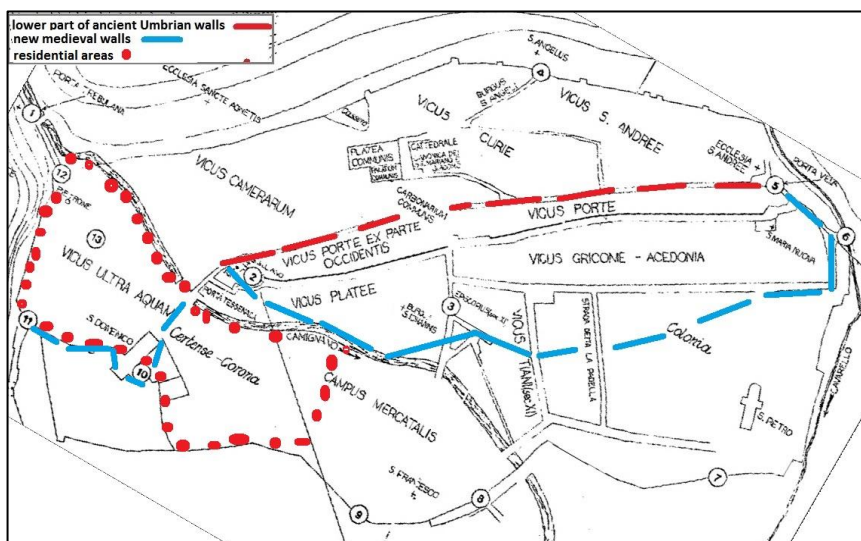


Figure 5 - "Agobio" until 12th century

According to Costantini⁴, between 10th and 12th century other “vici” or settlements grew up, expanded and were partly surrounded by walls, only partly new. These “vici” were the more inhabited areas and in 14th century would be joined to create the 4 districts around which the walls – as they are today - would be built. For instance, the “Vicus ultra aquam” in the left of the image is where the noble landowners settled since 11th century and that will be the first seed of modern Saint Martin district.

² P.L. Menichetti, op. cit., p. 453

³ A. Luongo, op. cit.

⁴ F. Costantini “Ipotesi sulla topografia dell’antica Gubbio”, 1970

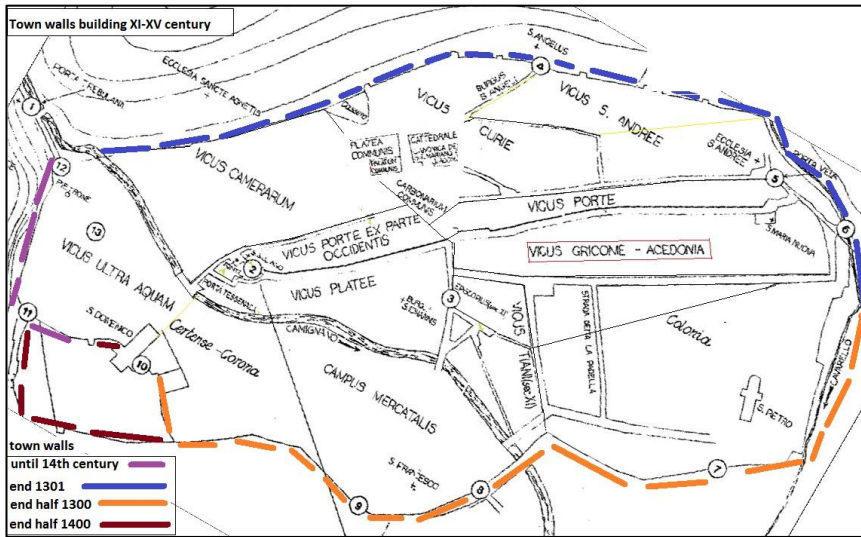


Figure 6 - town walls expansion until xv century

Roman Empire and led to newly occupy the half-shore slope and to include a large part of the Umbrian city up to the left bank of the Camignano river (green areas). On the right bank of Camignano river the traffic of goods and people from/to the Marche region trough the valley between Ingino and D'Ansciano mountains was ensured by “Vicus Ultra Aquam” (“district beyond the river”).

The second phase, however, had the maximum development between the 13th and 14th centuries occupying the space NW of Camignano river (“Corona”, and “Campus Mercatalis”, the current “Mercato”) and SE (the present district of San Pietro, the ancient “Colonia”). In fact, with the mere exclusion of the expansion made towards NW by the Dominican monks (figure 7 – pink area), the expansion of the old town got the definitive and modern shape in the mid 1300s.

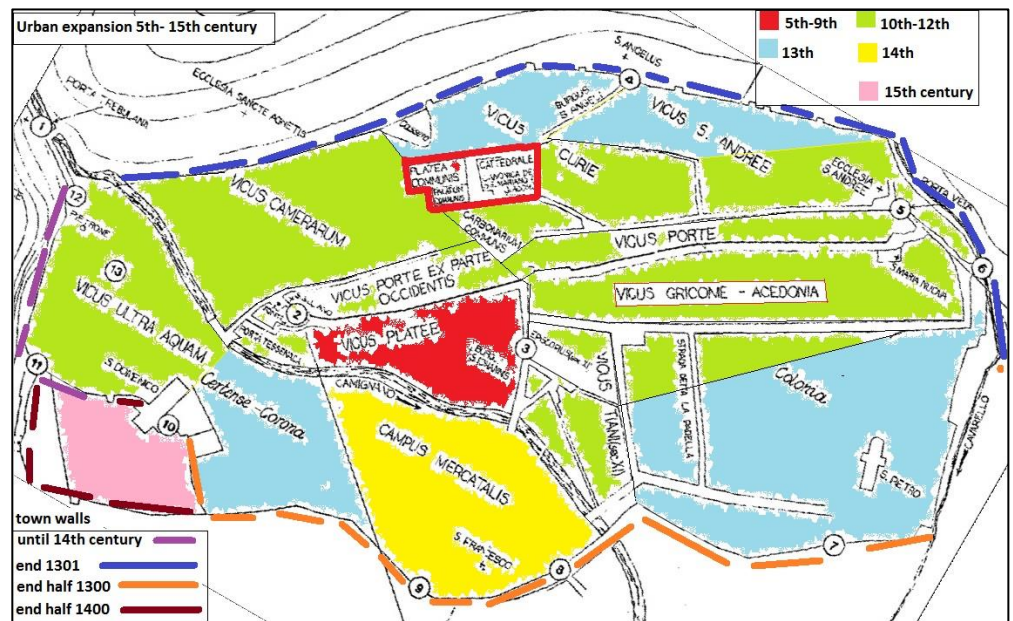


Figure 7 - steps of Gubbio’s urban expansion from 5th to 15th century

Since then started a period of decline politically (as a free commune that led to the Montefeltro’s domination) and economically (due to the crisis that followed to the great Bubonic Plague epidemic). The shape of Town walls as they look today stopped at that time. In particular, the N-NW walls (surrounding St. Martin district) were already made; the N-E part were completed in 1301 (year reported in the bas-relief beside S.Angelo gate – Zone 4 of Heracles test beds).

⁵ A.Luongo, op. cit.

The great urban expansion of Gubbio took place during the 12th and 13th centuries, when positive political and economic conditions developed in Gubbio the competition for the domination of the city between the ecclesiastical, the noble-latifondistic and the popular (artisan) components and hence both the expansion of the residential areas and the wall⁵. In particular, the first phase (see figure 7)

took 7 centuries since the fall of the

The Walls areas to focus on

- i. Zone 1 (“Forte di Parco Ranghiasi”);
- ii. Zone 2 (“Cassero”);
- iii. Between zone 3 (“Torre”) and zone 4 (“Porta S. Ubaldo”)
- iv. Between zone 4 and zone 5 (“Bughetto”)

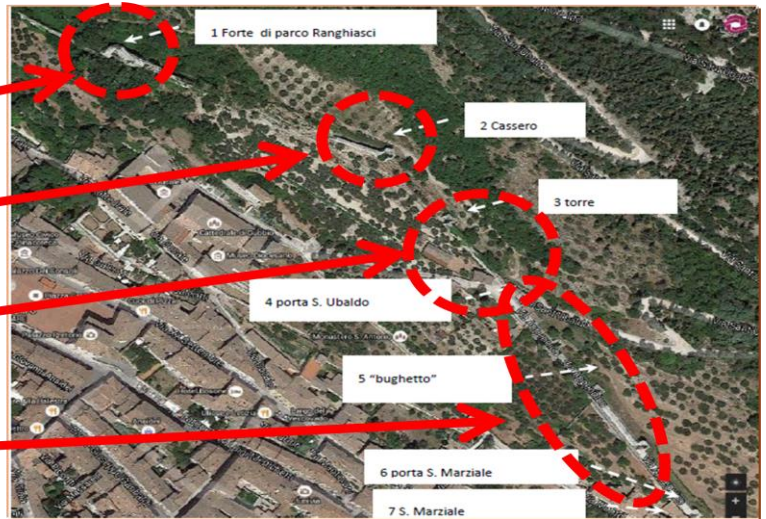


Figure 8 - test beds areas

The walls built along the plain (NW-SE) were completed before 1350.

After then, there were restorations and renovations (e.g. the complex of the double door of St. Peter in 1388 and the “Ponte Marmoreo” in 1481, demolished in the last part of the 19th century).

The Zone 1 (“Forte di Parco Ranghiasi”) as seen above was built in the Umbrian period, more than 2500 years ago, and then due to the last city expansion, completed in 1301. The walls protected the “Cassero”, a fortification built nearby, close to an ancient gate (“S. Agnese” according to Micalizzi) that led to the gorge of Bottaccione through probably an ancient Umbrian road whose remains can be seen few meters downstream of the middle age aqueduct. The gate was named after the monastery of S. Agnese and was built upstream



Figure 9 - Test bed sites zones 1 -2 -3 (J.Blaeu 1663)

and was built upstream and outside the walls. It was demolished to build the Rocks of Mount Ingino at the end of Middle Ages. The “Cassero” was built during Middle Age, modified several times, mostly between 1376 - 1386 and 1413-1414 by Mastro Agnolo da Como during Montefeltro’s domination, when it became definitively part of the defensive system of the city. In the 19th century due to the building of Marquise Ranghiasi-Brancaloni’s park, the “Cassero”, already damaged, was demolished and the gate disappeared. There are today a few ruins and ancient maps and engravings to witness their presence.

The map draw by J. Blaeu in image 9 above, shows how the "2 zone - Cassero" building looked like then (as it is today named popularly but erroneously). The appearance of that tower looked like a 3-storey structure, also closed towards the valley (now partly demolished).

The area nearby, nowadays is mostly interested by olive plantations, while in the past was also used by wood-cutters and farmers. From historic information, i.e., pictures and paintings, it was possible to point out how the forestation, currently visible outside the walls, is very recent and has arisen only just after the World War II. In fact, in the past, only few trees and bushes were present and unable to stop sediments and surface flows.

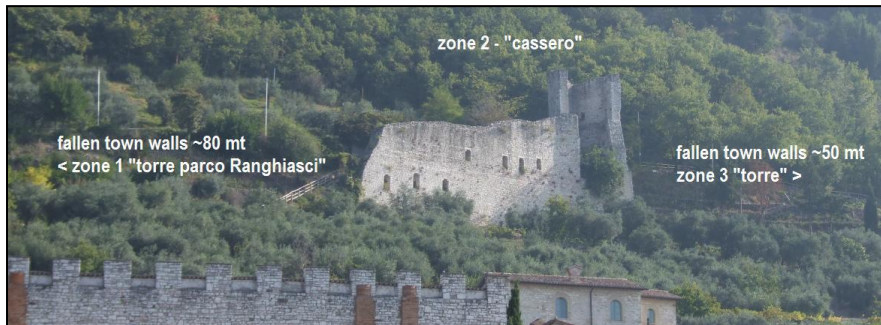


Figure 10 - fallen walls (after XVIII century)

During the last 8-10 centuries, several meters of soil accumulated against the walls. The situation was only partially mitigated in zone 1 by the historic aqueduct, which had also the function of a retaining Walls, too. At present, the estimated soil accumulation, insisting on the Walls, is more than

5/6 metres, so it has been increasing with a rate of around 50 cm / century.

As risk mitigation action, the water flew out through the Walls and the drainage of the gravel soil were ensured by means of on-purpose designed holes/channels in the structure. However, the ground material obstructed the channels. This caused the increase of the groundwater level and consequently the risk of the structural instability of the Walls. Currently there are no major landslides in place, but collapses of the Walls occurred over the last centuries. Just upstream this building was made a restoration over thirty years ago, removing the soil accumulated upstream of the walls and pushing on them. A 6 metres concrete retaining wall was built, with post-tensioned cables placed far ~4 metres from the ancient structures and finally reshaping the slope uphill. The walls in zone 3, however, have not been subjected to interventions in the recent past, so that the main danger is represented by the build-ups of moving terrain that can reach several meters of altitude.

As well, in following images, the same opening on the walls is shown, as it appears from the two different Walls sides (upstream and downstream). It is possible to see the great difference in height with respect to the ground level, upstream and downstream. Upstream, the opening results at ground level, meanwhile downstream, it is at an height of almost 6 meters from the ground level. It means that from the mountain side, at least 6 meters of soil are pushing on the Walls.



Figure 11 - zone 3-4: Walls downstream side (on the left) and upstream (on the right) - notice the opening at around 6 metres from the ground level downstream and the same opening at ground level on the right.

The opening is indicated by a red circle. The downstream ground level is indicated by a red arrow.

Between zones 2-3-4 there are many evidences of landslides consequences, such as the tilting and damage of various objects tilted like a flagpole and a wooden fence.

The zone 4 is popularly named “porta S. Ubaldo”, since from it starts the road that leads up the mount to S. Ubaldo Basilica where the incorrupt body of the Saint watches over the city. It was built in 1301 and then named “Porta Sant’Angelo”. It had on its top a covered level and in external part a bastion surrounded by walls (figure 12) that,

according to 1663 map, were completely above the soil level. Since that time the bastion was partially demolished and the soil reached the level of ~1/1,2 meters below the town walls, that means ~8 meters above the road



Figure 15 - Test bed sites 4 -5 -6 (J.Blaeu 1663)

downstream (Via Appennino). Two major interventions were made in this part of the Walls (zones 4-5-6). These interventions were aimed mainly to remove the thousands of cubic meters of soil carried there by rains, since it was intensifying the load on the Walls and increasing the aquifer water levels. The intervention was made 8-10 years ago and divided in two parts. The first one concerned the part of the Walls between S. Ubaldo and S. Girolamo doors for about 125 m. The soil slipped against the Walls over last centuries was removed and it was used to make rammed-earth wall or "retaining/reinforced earth wall" (about 3 metres upstream of, and parallel to the Walls); the hollows present in the collapsed areas were filled; the external facades were restored (eradication of plants, roots and weeds shrubs using pesticides, without affecting the existing binder; treatment with anti-mould and anti-moss; surface cleaning of the stones with low-pressure water cleaner; filling of the joints and cracks of the stones with mortar). Finally, a



Figure 12 - zone 5: the slope before intervention



Figure 13 - during intervention



Figure 14 - after excavation during earth-retaining walls building

resin has been used to protect all the surfaces.

In zone 5 there are today 4 watch towers that interrupt the walls. The historian Micalizzi (1989) pointed out that these towers were built aligned with the main roads going upstream-downstream of the eastern part of the town, while a fifth tower (reported in ancient map by Ghelli) is today missing (probably destroyed).

In the Blaeu map (1663) is not reported the opening on the wall leading to S. Girolamo monastery, so that it should have been made later. Infact, as it can be seen in figure 2 (lower-right side), it is not a real “city gate”.

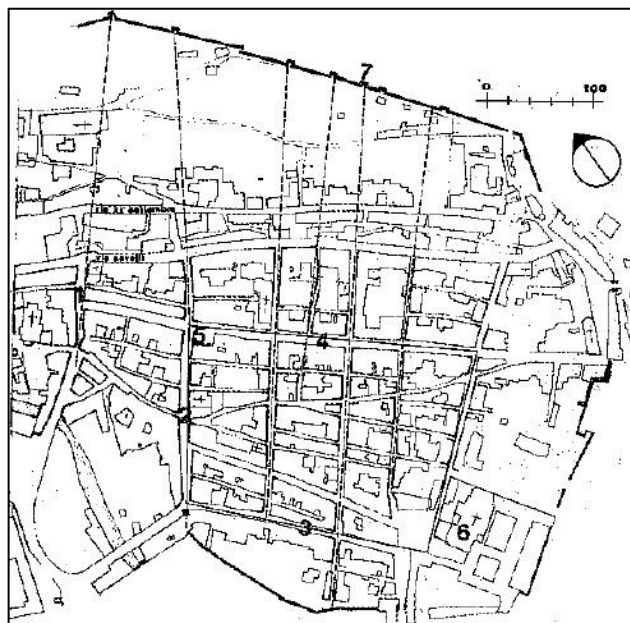


Figure 16 - alignments of the wall towers with main SW-NE roads

GENERAL RISKS/HAZARDS AND TECHNICAL ASPECTS

As specifically reported in the previous chapter, the Walls suffer mainly from torrential rains and humidity characterizing the soil surrounding the area and closely connected with the mountain natural area. The heavy rains increase the push on the Walls in two ways: the first one is through the washout producing and transporting rubbles, the second one through the increase of the aquifer level. All these conditions can adversely affect the statics of the Walls themselves.



Figure 17 – ancient wall collapse in via del Monte

In the last decades many catastrophic episodes occurred, especially in the northern side of the town, such as collapses of **medieval terracing** (integrated parts of the town Walls or previous walls itself), a 300 cubic-meters chasm opened in the *Duomo* garden.

In addition, the Walls of Gubbio exhibit several issues related to the materials degradation (limestones, travertine, sandstone-serena stone, plasters, binders) used for building and restoration. These materials suffer of increased deterioration due to climate change effects coupled with pollution. The structural material principally used is the limestone extracted from the quarries site in the neighbouring mountains in

two different extraction periods. The oldest limestone was extracted prior to 15th century and does not exhibit significant criticalities. The second limestone type (extracted later) is affected from a significant degradation with the formation of dark patina (“Black crusts”) on the surfaces.

Another predominant issue is the gradual degradation of the mortar binding the walls and that makes spatially uniform the stresses

through the joints between the stones. The degradation/reduction of the mortar entails the

loss of homogeneous distribution of the stresses on the surface of the stone and leads to a heterogeneous stone-binder system behaviour. The action of the rainfall on the materials, principally the mortars can cause erosion of the weakest parts of the masonry that can be coupled to Hydrolysis, Oxidation and Dissolution. The degradation effects of the outer surface are: loss of material (formation of hollows, differential degradation, erosion, gap, lacking, pitting); decay of the material cohesion (disintegration, pulverization); loss of continuity perpendicular or parallel to the outer surface (fracturing/cracking, peeling, warping, swelling, scaling); addition of foreign material (concretion, crust, surface deposit, efflorescence, scaling, stain, film); colour variations (discoloration and patina).

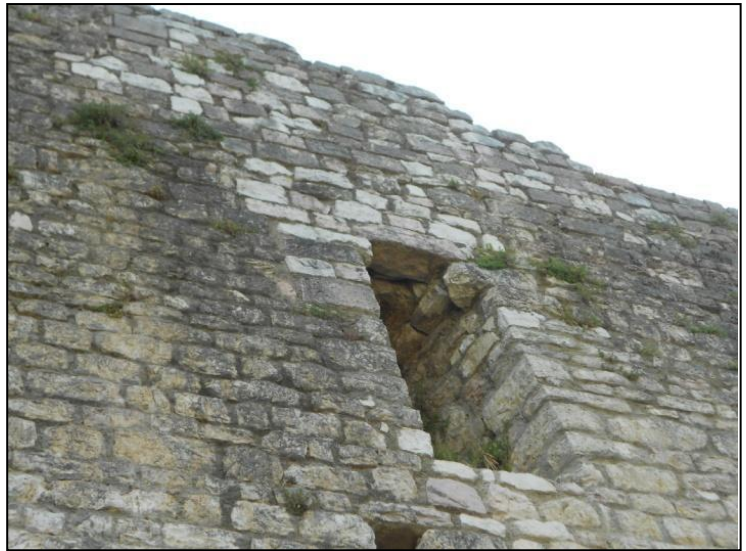


Figure 18 - dark patinas and differential blackenings

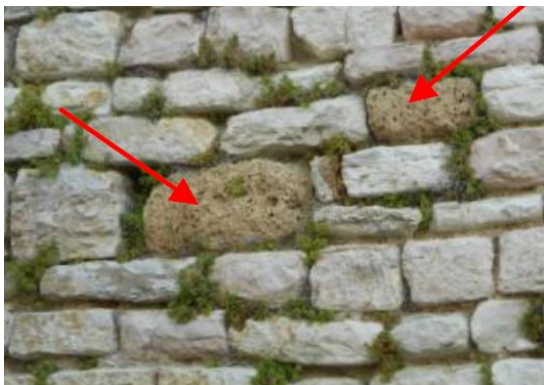


Figure 19 - Travertine stones



Figure 20 - sandstone bricks

The presence of stones different from limestone such as travertine or sandstone can get the static equilibrium worse. Infact the city Walls were also built with waste materials from abandoned and ruined Roman palaces/villas of the Roman Urbe in the valley that were used as a quarry.

These porous stones deteriorate faster than those of limestone, so the Climate Change may further accelerate this phenomenon leading to structural instability.

PRESENTATION OF THE PROJECT

The project has been presented through different events:

“EMRS SPRING MEETING”, 22ND MAY 2016, STRASBOURG, FR

The project has been presented through a satellite event of the EMRS Spring meeting: Europe in Motion. During this half-day session, coordinators from different European projects presented their project to the audience, and European Commission Senior Official H el ene Chraye presented the strategy of the European Union in the material science field. HERACLES coordinator Giuseppina Padeletti presented the project during this session.

Furthermore, during the whole Spring Meeting (22nd to 26th May), the project has been presented through powerpoint presentation, distribution of flyers and goodies at a booth dedicated to running European projects.



PRESENTATIONS AT PRINCETON, COLUMBIA AND BERKELEY UNIVERSITIES (30/03, 03-04/04/17)

University of Perugia’s Filippo Umbertini and Anna-Laura Pisello delivered a presentation at three American Universities in March and April 2017. A.-L. Pisello gave her presentations on Princeton on 30 March 2017, F. Umbertini at Princeton and Columbia on 03 and 04 March 2017.

Both evoked the project during their presentation, and detailed the objectives and methodology of HERACLES.

PRESENTATIONS DURING THE EVENT “L’ORO DI GUBBIO”, 7-8 APRIL 2017, GUBBIO, IT

Gubbio and e-geos gave a presentation entitled “Tecnologia al servizio del Patrimonio Culturale: il progetto HERACLES” (*The technology to serve the Cultural Heritage: the HERACLES project*) during “L’oro di Gubbio.” This event involved more than 200 people among local population, technicians, experts in the field of conservation and restoration.

FUTURE EVENTS

Mid-july, IACM-FORTH will organise a Virtual Course entitled “Methodologies for Climate Change impact evaluation and risk and vulnerability analysis.”

This HERACLES Virtual course will last two hours, and will be presented by an instructor using PowerPoint slides and audio. The link to follow it will be available on the HERACLES website.

The course being recorded, you’ll also have the possibility to watch it at any time.

The precise date will be communicated soon. No registration is needed.