

GPR prospecting on masonry walls in a high seismic hazard region: the resilient Castellina Museum of Norcia (Central Italy)

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I. INTRODUCTION

Problem: the conservation of historical masonry buildings is a major challenge of scientific research, especially in the case of monumental structures with high artistic and cultural value located in high seismic hazard regions, such as in Central Italy. **Goals:**

- apply non destructive tests (NDT) on mansory walls of an historical building damaged by a strong earthquake (2016-2017)
- obtain informations on the internal structure of the wall, useful for the recovery of this cultural heritage
- use high frequency Ground Penetrating Radar (GPR), to obtain high-res images of the walls (inside)
- compare/combine the Ground Penetrating Radar (GPR) results and Sonic Tests on a selected portion of the walls - improve the knowledge of masonry conditions by the combination of NDT results

Study site: Museo Civico and Diocesano della Castellina (Norcia)



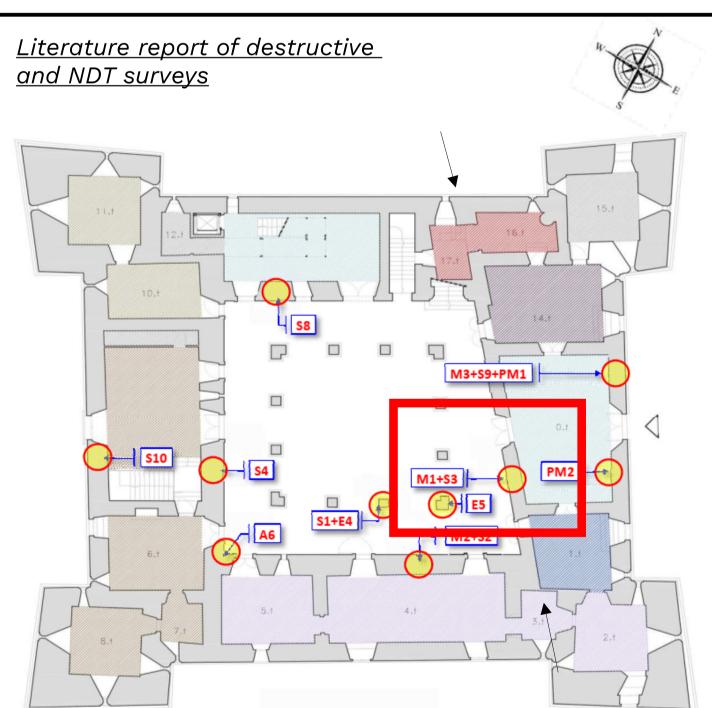
museum at Norcia (Central Italy

damages caused on the several walls also were subjected to

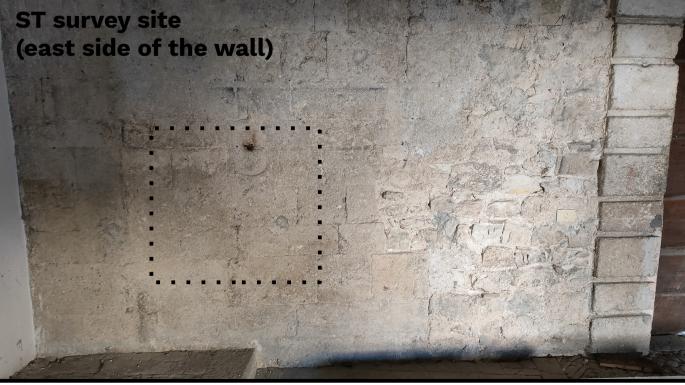
- the Museum is located in the Norcia's historic centre
- it is a testament to resilience, designed by Jacopo Barozzi da Vignola
- constructed in 1554, used for the control of territories by the Church State - 18th c. restoration after earthquakes, 1860-1967 municipality, then museum
- regular geometry, built over an ancient (demolished) Podestà Palace
- only the front its façade was incorporated into the fortress structure.
- our geophysical survey focused on this mansory wall

II. NEW NDT DATA

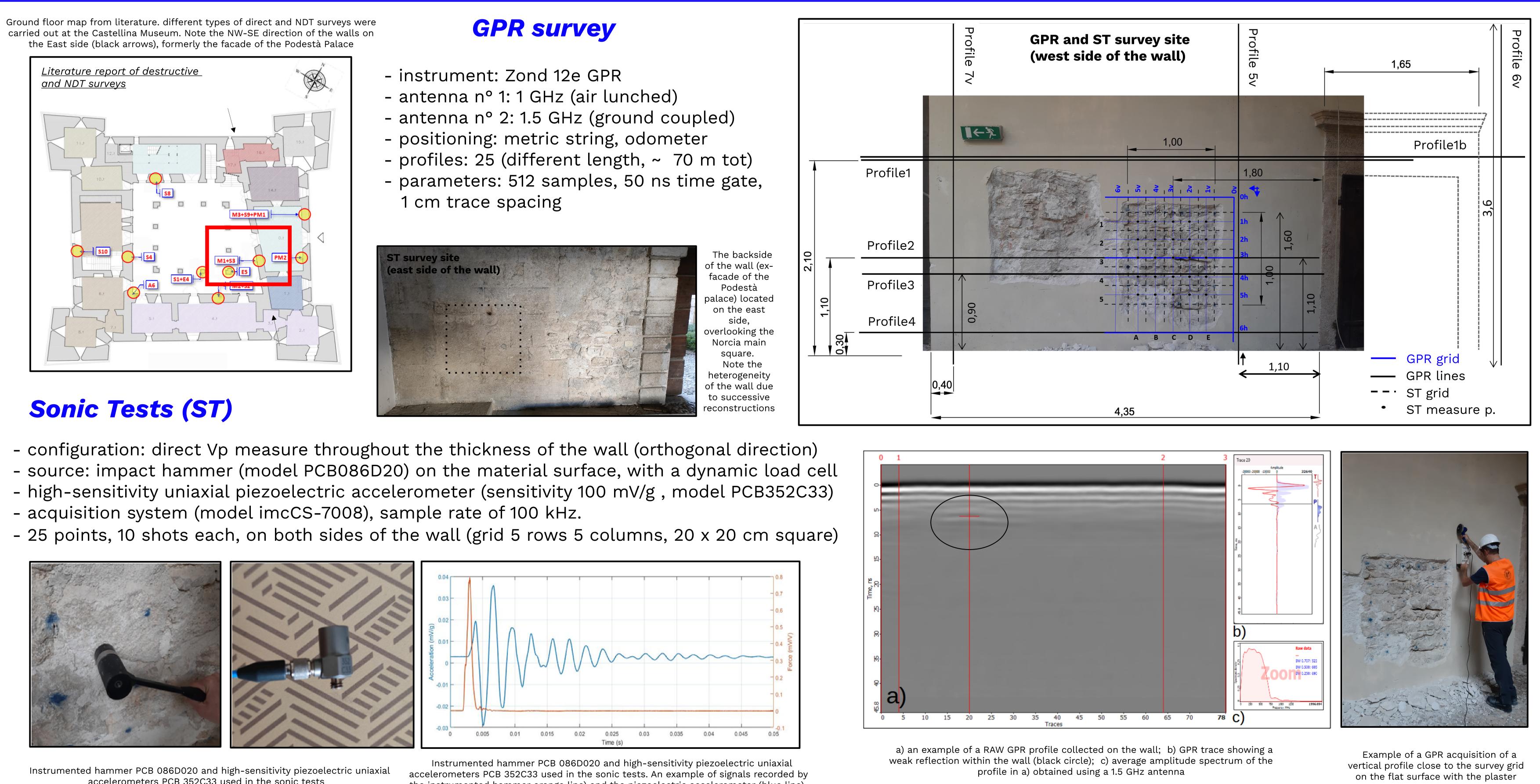
carried out at the Castellina Museum. Note the NW-SE direction of the walls on



- 1 cm trace spacing



side,



accelerometers PCB 352C33 used in the sonic tests

the instrumented hammer orange line) and the piezoelectric accelerometer (blue line)

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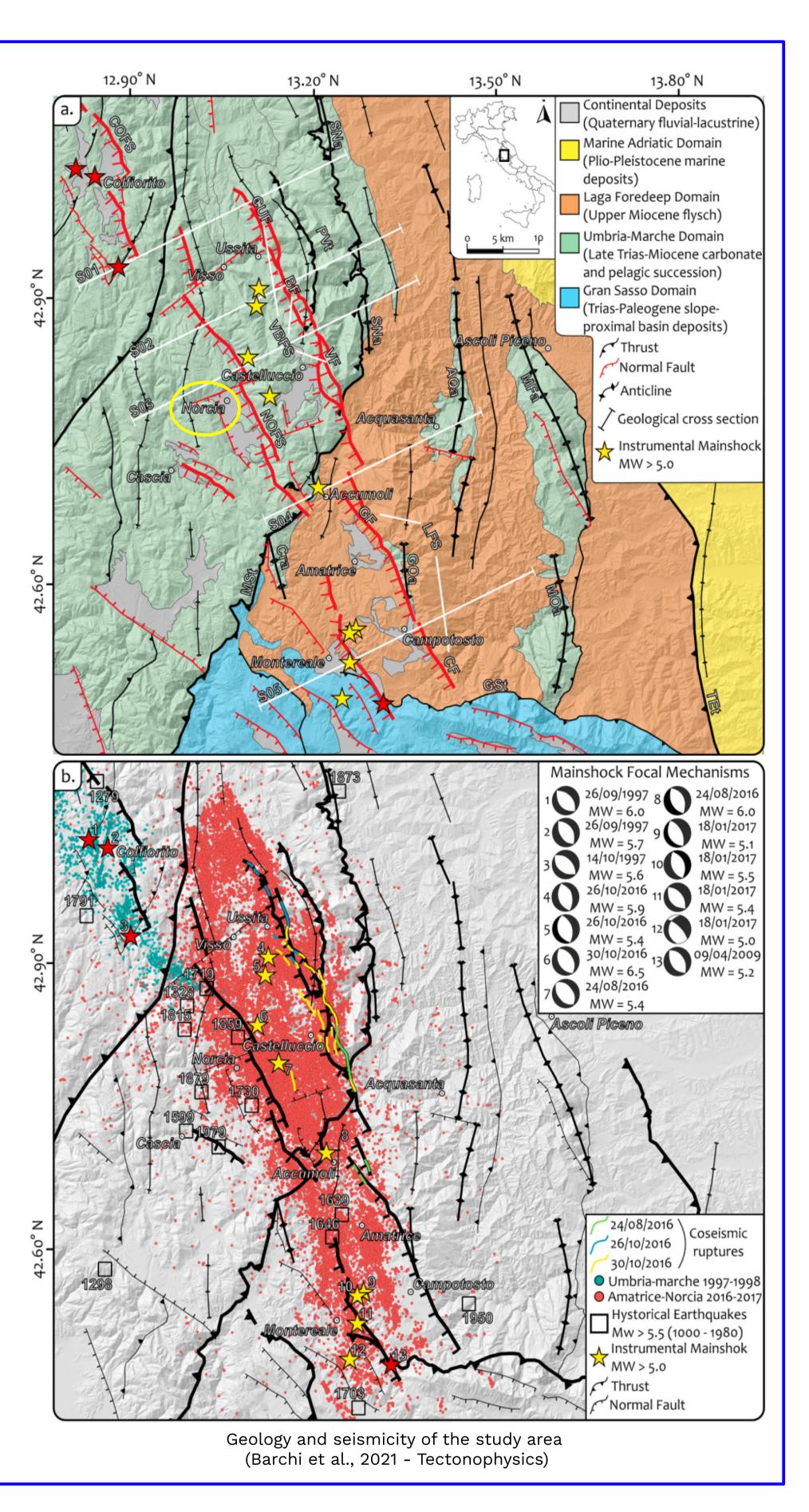
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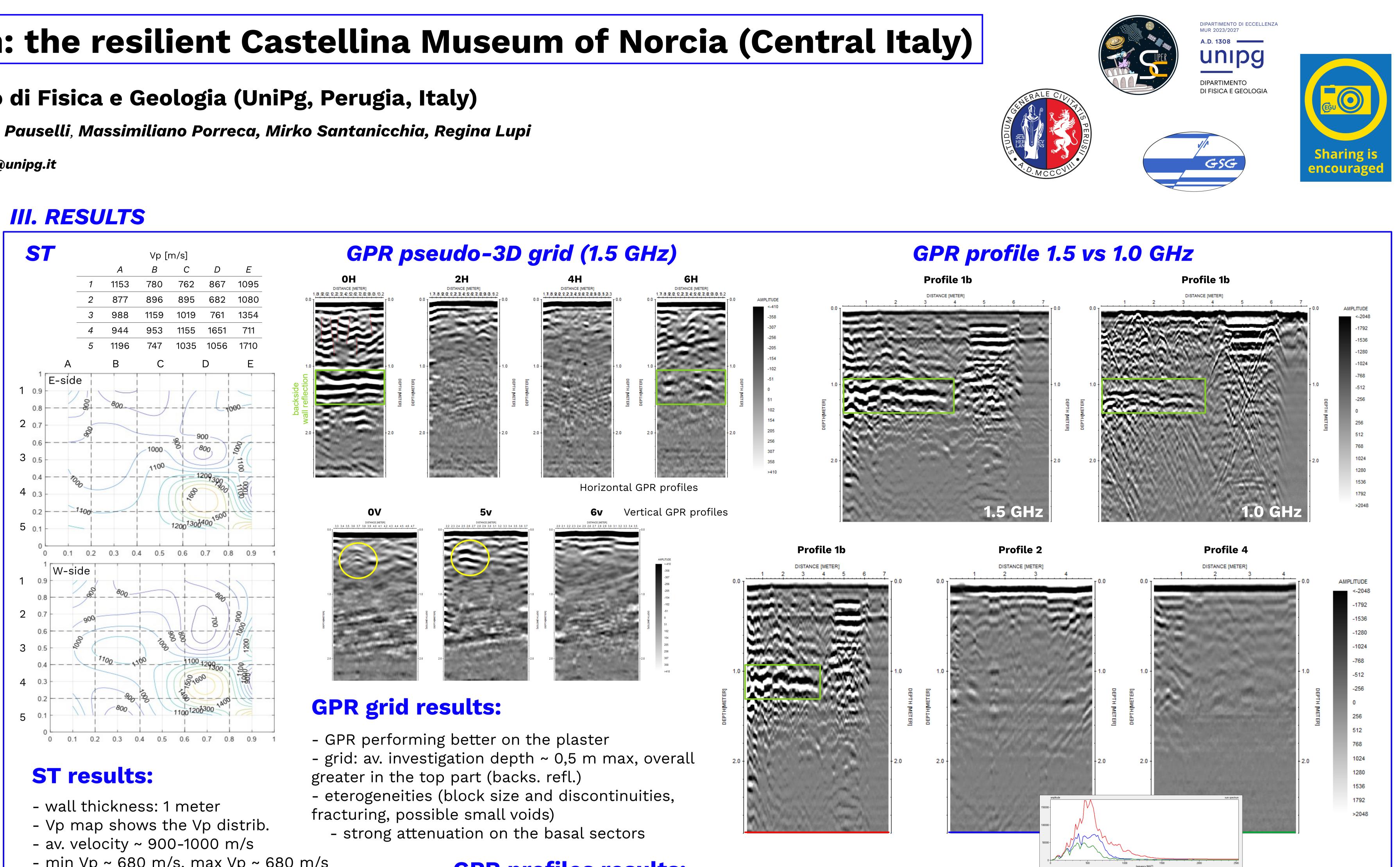
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cia square after the seismic events (1703) Bufalini F. A., edited from G. Desnoudes 1706



San Benedetto cathedral after the earthquakes (April 201





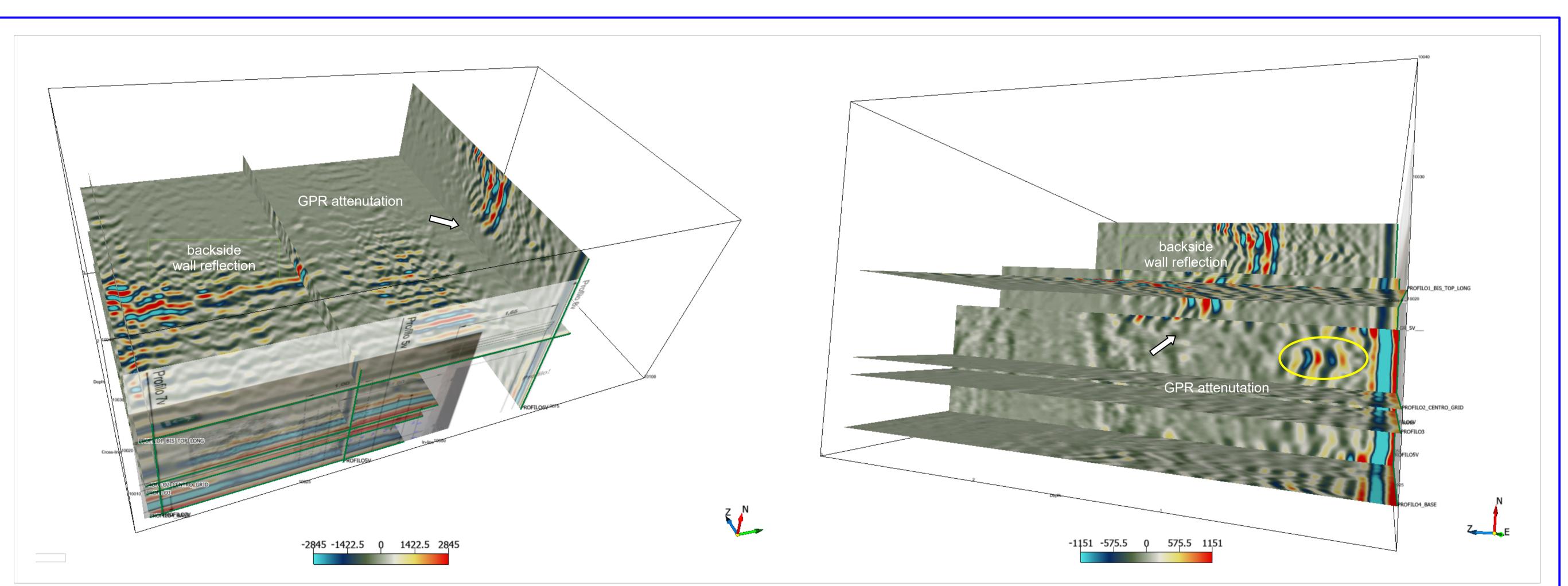
- min Vp ~ 680 m/s, max Vp ~ 680 m/s
- low Vp: interpreted as more degraded areas
- (soft/rebuilt material, mortar, fractures, voids)
- high Vp dense (limestone, compacts blocks)

IV. CONCLUSIONS AND FUTURE WORK

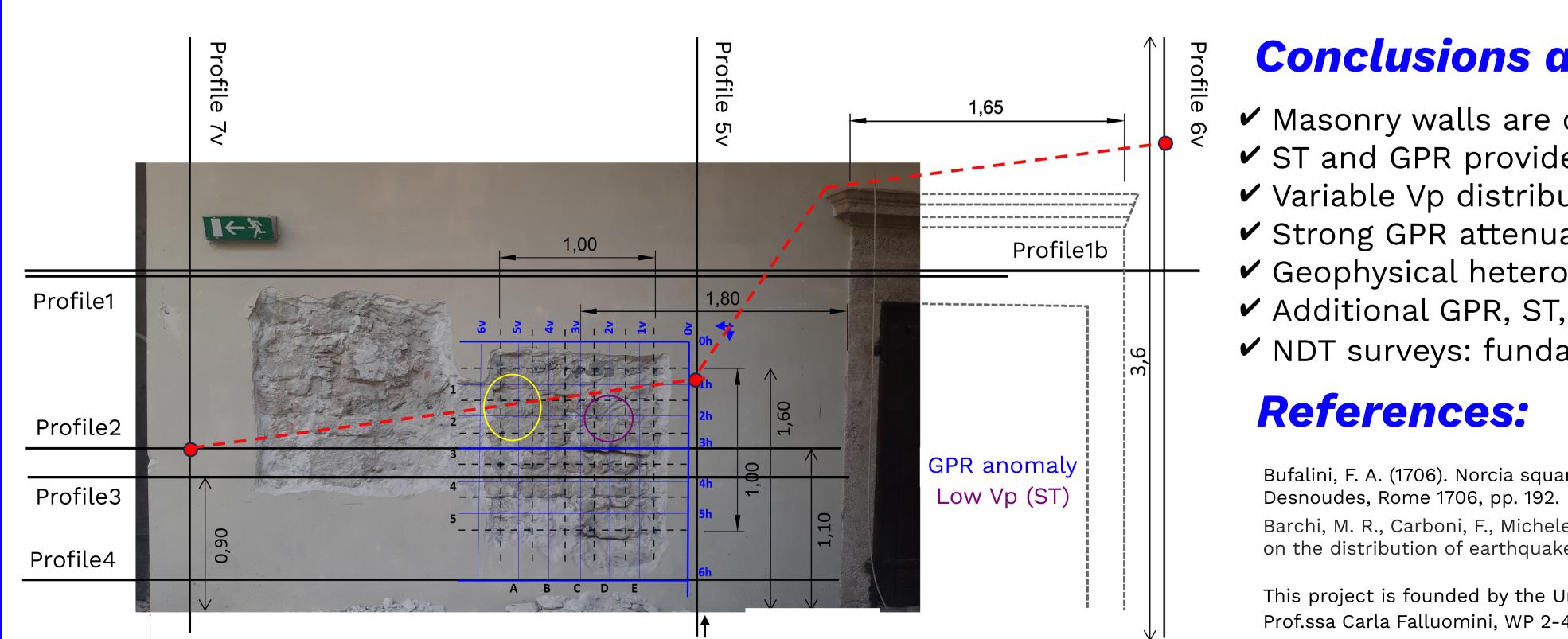
3D GPR visualization

Using local coordinates, all the GPR data are imported in a seismic interpretation software, to aid the evaluation of the masonry wall conditions.

Notice the sharp and strong GPR signal attenuation occurring at different levels from the ground floor, but completely interrupting the backside reflection of the wall (white arrow).







GPR profiles results:

- backside wall reflection only on the top GPR profiles, high (increasing) attenuation (> e. conductivity) toward the floor - variable GPR signature within the wall, due to the etherogeneities and quality of the materials

Conclusions and future work

Masonry walls are complex and very heterogeneous structures ✓ ST and GPR provide info on the internal structure and walls state Variable Vp distribution and GPR reflection strength and reflections' continuity Strong GPR attenuation (high el. conductivity ?) toward the floor to investigate Geophysical heterogeneities to further interpret as voids, material quality, defects ✓ Additional GPR, ST, as well as ERT and archaeometric analysis will be carried out ✓ NDT surveys: fundamental use to preserve historic buildings and cultural heritages

Bufalini, F. A. (1706). Norcia square after the seismic events (1703), Lettres de G.D. et de M. Gugliemini, edited by G.

Barchi, M. R., Carboni, F., Michele, M., Ercoli, M., Giorgetti, C., Porreca, M., et al. (2021). The influence of subsurface geology on the distribution of earthquakes during the 2016-2017 Central Italy seismic sequence. Tectonophysics 807, 228797.

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EGU 2024 Abstract



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