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PRELIMINARY RESULTS OF THE ARCHAEOLOGICAL POTENTIAL MAP IN SITAR

1. ArcheoSITAR project: an overview

The ArcheoSITAR project, launched in 2007 by the Soprintendenza Speciale Beni Archeologici Belle Arti e Paesaggio di Roma (SSABAP), represents a significant step forward in the digitization of archaeological data. This project, developed by the SSABAP, aims primarily at transforming its vast paper archives related to archaeological excavations in Rome into a digital format, making them easily accessible and complete. The Sistema Informativo Territoriale Archeologico di Roma (SITAR) is currently the largest digital archaeological archive in the city and can be publicly accessed via a webGIS platform. Through this platform, detailed archaeological data and documentation are made available to the public freely and as open data. Given that this system is already well-known in the scientific literature, we would like to present two recent developments: the integration of data from external sources and the ongoing work on the Archaeological Potential Map of the city of Rome.

2. Workflow for external data integration

The need to enter data in real-time without having to catch up with the digitization of old archives has prompted SSABAP to devise a method that allows for the immediate integration of information into the system. This has led to the design and implementation of an innovative platform that will improve access to and use of digital archives. The procedure that will be implemented involves, from an administrative perspective, the opening of the source of information, i.e., the level of the system managed by the office will be made available to accredited external users. This opening will allow archaeologists to interact directly with the platform, enabling professionals to enter data immediately during or shortly after the investigation. It will no longer be necessary to produce data that require further processing; instead, validated data will be uploaded immediately, while attachments will retain the seven-year preservation requirement before publication.

SITAR is currently testing and will soon release a new tool for its platform called the 'External Data Entry Module'. This module will be a fundamental component of the ArcheoSITAR project, enriching and enhancing the database. The new SITAR platform will be accessible to external collaborators who, after completing a short training course, will be accredited on the portal. Thanks to the collaboration with the Fondazione Scuola del Patrimonio,

independent professionals will be able to access the necessary training to obtain the pass to the platform, thus facilitating their contribution to the project. The accreditation portal will be open to independent archaeologists, cooperatives, and associated studios. As previously specified, the workflow will begin with the assignment of the work area called 'Origin of Information' (OI)[1] (Serlorenzi, Lamonaca, Picciola 2012, 38-40) to which the accredited operator must upload the administrative documentation, complete the general excavation information, and enter the three main elevations above sea level (road surface, archaeological surface, and geological surface). The workflow will continue with the submission of contextual data 'Archaeological Partitions' (PA)[2] (Serlorenzi, Lamonaca, Picciola 2012, 40-41) through the online portal where external collaborators will upload excavation reports, photographs, and other relevant documents. Before being uploaded online, all externally entered data will be carefully reviewed by the SITAR office to verify their accuracy and authenticity.

After this verification, a notification of approval or a request for integration will be sent to the collaborators who provided the documentation. Only after final approval by the Soprintendenza will the data be standardized and coded into the SITAR geodatabase, which currently includes nearly seven thousand archaeological excavations (OI) and over twenty thousand archaeological context units registered (PA). This process ensures seamless integration with existing records, contributing to improved use of the platform for both academic research and urban planning.

To ensure effective collaboration, detailed guidelines have been made available on the ArcheoSITAR project website for several years, describing the methods for data submission and integration. These guidelines provide clear instructions on how to prepare and submit data, ensuring that all contributions meet the required standards. In this way, the system can continue to grow consistently and reliably, maintaining its usefulness as a key resource for managing and understanding Rome's archaeological heritage. The inclusion of external data will not only improve the quality of the information in the system but also enhance the research work to develop the archaeological potential assessment tool. Thanks to the contributions of external archaeologists, the

[1] The Origin of Information (OI) is the level that narrates the history of the archaeological investigation and collects all the demographic, technical, and descriptive information that allows identifying the source of the data. The Origin of Information encompasses the area of archaeological investigations conducted at a site for infrastructure or private construction, a topographical or archival source, scientific research, surface surveys, or geognostic investigations.

[2] The Archaeological Partition (PA) is the analytical level of information and records all the findings identified by each investigation. The Archaeological Partition represents the evidence uncovered, generated by human activity in the past: a section of a road, a tomb or necropolis, a room, a villa, a thermal bath complex, a wall structure, traces of quarrying or agricultural activity, and much more.

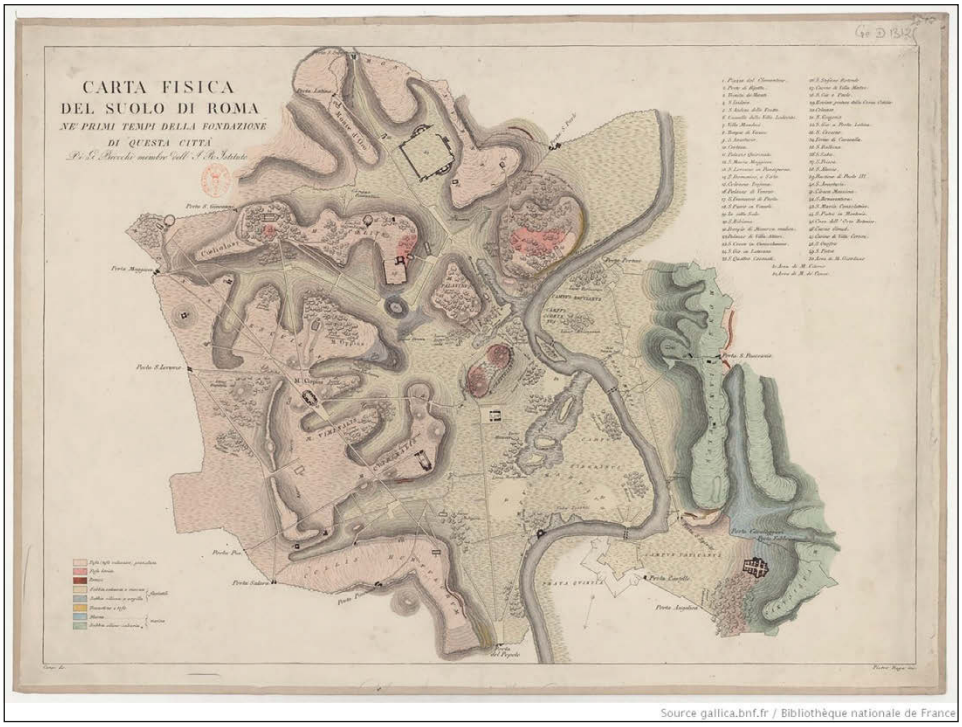

Fig. 1 – The *Carta fisica del suolo di Roma nei primi tempi della fondazione di questa città* by Giovan Battista Brocchi in 1820 has been rotated 180° to facilitate geographic reading since the original is oriented South instead of North.

database will be continuously updated, allowing for a more accurate assessment of the archaeological potential of different areas of the city, benefiting both research and urban planning[3].

3. Scientific and academic research on archaeological potential

For a brief history of reaserch on archaeological potential in urban contexts, we considered some previous studies. In Giovan Battista Brocchi's famous 1820 map, entitled *Carta fisica del suolo di Roma nei primi tempi della fondazione di questa città* (Brocchi 1820a) (Fig. 1), we find the first attempts to imagine the territory of Rome before the significant construction phases of the Republican and Imperial eras. Although lacking associated elevations, this attempt is certainly evocative and demonstrates the willingness

[3] https://www.archeositarproject.it/manuale-uso/linee-guida/.

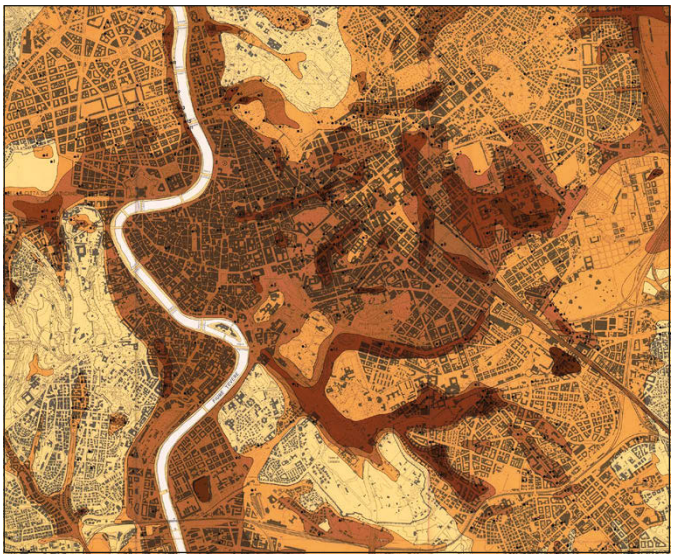

Fig. 2 – Detail of Ugo Ventriglia's map *Spessore della coltre dei terreni di riporto* for the *Carta geologica della città di Roma*.

and competence to address such a complex problem. Reading the compendium associated with the map *Dello stato fisico del suolo di Roma, memoria per servire d'illustrazione alla carta geognostica di questa città* (Brocchi 1820b), one perceives the incredible effort to represent through sources what might appear as a 'non-problem' – the orographic definition of a city in the original state of its geological nature. However, Brocchi goes further by addressing the geognostic definition of the city with this compendium, not only following proto-scientific methodologies of sampling and mapping the nature of the soils, but also applying a philological methodology, gathering clues and descriptions of Rome's orographic conformation from the major Latin authors.

This research is the basis and inspiration for geognostic studies of Rome in the following centuries. In his work *Sulla storia fisica del bacino di Roma*, Ponzi, through his *Memoria*, attempts to build on Brocchi's meticulous observations, detailing the physical history of the Roman basin. He describes the transformations that altered the landscape up to historical times (Ponzi 1850). Moving into the 20th century, Ugo Ventriglia's interpretation of the map *Spessore della coltre dei terreni di riporto* (Ventriglia 1971b) (Fig. 2) is crucial. This map serves as a compendium to the *Carta geologica del Comune di Roma* (Ventriglia 1971a, 180-188), where 'terreni di riporto' refers to terrain with high archaeological potential. Although Ventriglia's approach is primarily geostatic, aimed at mitigating the effects of underestimating

construction problems in areas with anthropogenic underground cavities and high archaeological potential, his map, read by subtraction, provides the first metrically measured scenario of the 'Modified Geological Surface' of central Rome.

More recent editions of the same map come from more recent and accurate studies (Funiciello 1995), with a more detailed focus on the eastern area of Rome, particularly the V Municipality (Mazza, Capelli, Lanzini 2008). The concept of archaeological potential in urban areas, particularly in Rome, has been a focal point of scientific and academic research for several years. Studies have aimed to quantify the likelihood of discovering archaeological remains in various urban contexts by analyzing historical, archaeological, urban, and geological data. The first methodologically important archaeological study comes from the core samples and stratigraphic excavations of Metro C. During this project, a multidisciplinary research group composed of archaeologists and geologists conducted a zonal analysis between the stations of San Giovanni in Laterano and Porta Metronia. For the first time, this effort led to a detailed characterization through major epochs, including section analyses and 3D (Demetrescu, Fontana 2009). The discussion then extended to other cities in 2011. For example, the MAPPA project in Pisa (Anichini *et al.* 2011) established its methodological foundations during this period. Additionally, Sondrio recently adopted an innovative approach to developing an archaeological risk map (Tremari 2020).

Returning to focus on Rome in 2013, also within the SITAR project (Serlorenzi, Boi 2016) the system showcases in 'Archeologia preventiva predittiva potenziali archeologici' the Italian approach to these analyses with a focus on urban environments. The research involves the development of models that incorporate geological and geomorphological parameters, archaeological records, and spatial relationships between them. These models allow for estimating the likelihood of discovering significant archaeological deposits and their thickness, facilitating the preservation and study of Rome. Since the beginning of the 21st century, several geo-archaeological studies have focused on specific areas of the city, highlighting the complexity of urban archaeological stratification[4].

[4] Lugli, Rosa 2001 wrote about the *Capitolium*; Gioia *et al.* 2010 were involved in a study in the Torre Spaccata area; De Santis *et al.* 2010 in the *Forum* of Caesar, further explored by Delfino, Rosa 2014, although Matteucci, Rosa 2012, Buccellato *et al.* 2021, Rosa 2022 and Matteucci *et al.* 2023 published an interesting paper on various open issues along the Tiber River. Recently, there has been renewed interest in the area around the San Giovanni station of Metro C, with the studies of Bottiglieri *et al.* c.s., focusing on the *Castrense* amphitheater and the *Circus* of *Varius*. Additionally, a recent and noteworthy study by Bellitto *et al.* 2024 was published on the remains of a quarry in 'Via del Castro Laurenziano', in the eastern suburbs of Rome.

4. Qualitative and quantitative archaeological potential

The reflection on archaeological potential in SITAR aims to develop a predictive knowledge of Rome's subsoil useful for supporting and guiding the city's urban planning. Since SSABAP must authorize in advance the development of large urban projects in a city where the orographic conformation is almost entirely artificial and shaped by human activity, it is essential to have a tool that integrates archaeological potential into the design processes. In this way, archaeological potential is considered a resource to be valued rather than a simple risk to be managed. This data is crucial not only for archaeological research but also for ensuring informed and participatory urban planning, avoiding situations where those involved in administrative processes are not fully informed about the reasons for design choices.

SITAR has deepened the concept of 'clusters' related to confirmed archaeological evidence, using various sources to move from a two-dimensional to a three-dimensional representation, thus offering a more complete and detailed view of the city's archaeological potential. This process is not original; other previously mentioned workgroups have worked on this topic. Archaeological potential refers to the likelihood that an area contains archaeological deposits, buildings, or artifacts of historical significance. According to Anichini *et al.* 2011, the archaeological potential of an area is calculated through the analysis of various data sources, including historical records, previous archaeological discoveries, and paleoenvironmental data. The process involves evaluating the density, typology, and stratigraphy of known sites, as well as the geomorphological context. These factors contribute to creating predictive models that highlight areas with a high likelihood of containing archaeological evidence, expressed within the webGIS in meters. Figuratively speaking, qualitative potential is built and read horizontally and expresses its value through cartographic representation, while quantitative potential is vertical and expresses its value in section.

4.1 *Qualitative archaeological potential*

Qualitative archaeological potential assesses the risk of discoveries interpretatively, considering the historical, cultural, and chronological context. It analyzes the types, phases, and functions of archaeological elements to reconstruct consistent urban models over time. It includes archival research, historical map analysis, and interpretations of past human activities. This method deepens the archaeological relevance of an area, highlighting not only the artifacts present but also their historical and cultural significance (Fig. 3).

4.2 *Quantitative archaeological potential*

The quantitative approach to archaeological potential involves a systematic method of reclassifying archaeological data by integrating them with geological and geomorphological information. This process evaluates the distribution of archaeological samples by superimposing these data on both current urban development and the erosion of the historical landscape.

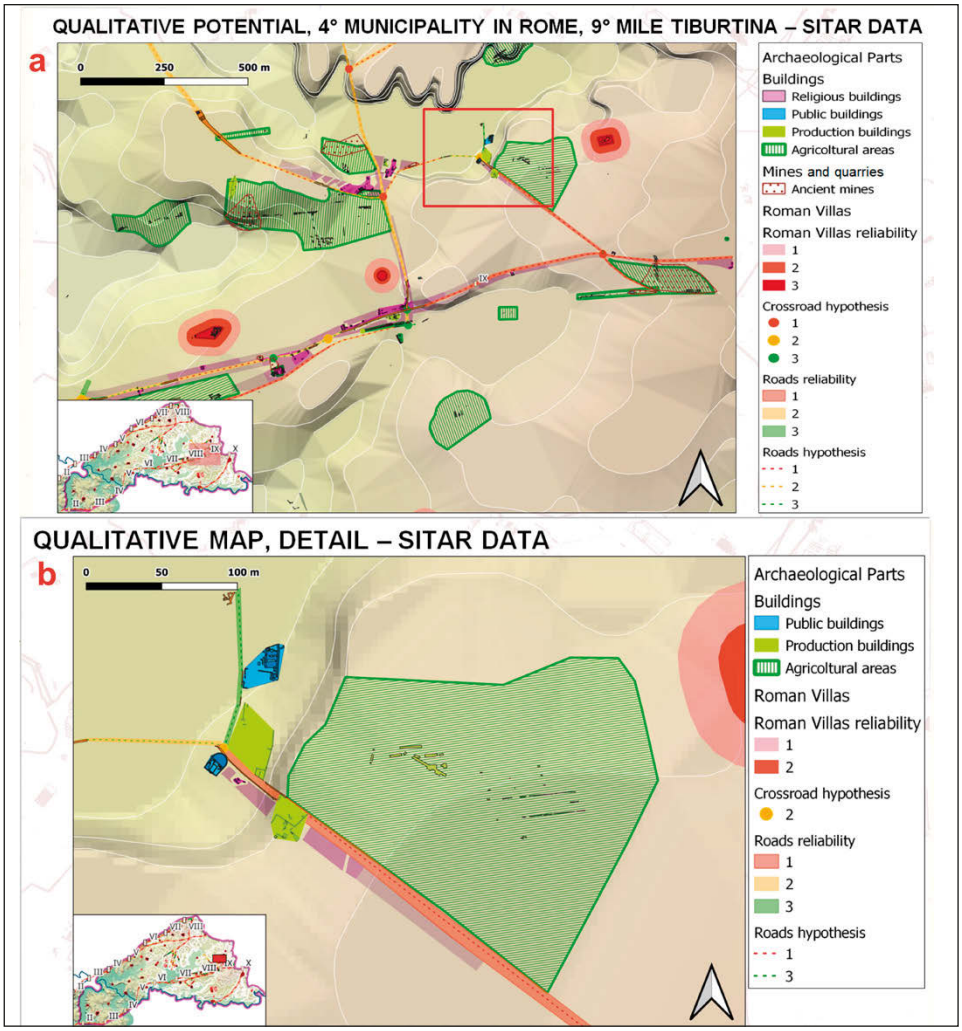

Fig. 3 – a) Qualitative approach used for the predictive map of a suburban area of Rome; b) detail covering the red square above (the map was drawn using SITAR data; many thanks to Dr. Fabrizio Santi SSABAP).

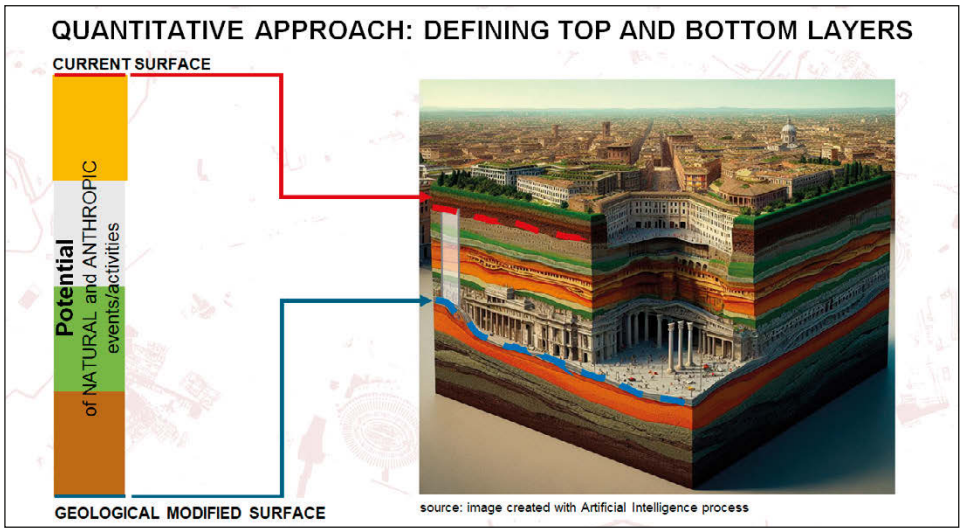

Fig. 4 – Schema of quantitative archaeological potential.

A key element of this approach is the creation of Digital Elevation Models (DEMs) that represent the topography of the surface in different periods. The first DEM is based on topographic data from the last 20 years, mainly from the Carta Tecnica Regionale del Lazio of 2002, and enriched by the surface elevations from the SITAR excavation database. The second DEM is derived from the interpolation of data from over 7000 core samples reaching the first geological layer, analyzed and interpreted by geologists (Fig. 4).

Moreover, an intermediate DEM is being developed using 1-meter contour lines from historical sources such as the *Piano regolatore di Roma* (PRG) (1908-1909) (Teulada 1909) in the central area, the Piano *topografico di Roma e Suburbio* (PTRS) (Comune di Roma 1924) for nearby suburbs, and historical maps with 5-meter contour lines from the Istituto Topografico Militare (IGM) dated between 1872 and 1895 up to the boundaries of the Municipality of Rome. This historical DEM is 80% complete within Rome's urban railway ring and is crucial for accurately reflecting past orographic conditions, assuming minimal topographic changes between the fall of the ancient world and the 19th century. The main sources for interpolating Rome's 'Modified Geological Surface' are:

– geology of the territory of the Municipality of Rome. Amministrazione Provinciale di Roma (Ventriglia 2002);
– Laboratorio di Idrogeologia Database (LABDIR) Department of Sciences, University of Roma Tre (Laboratorio di Idrogeologia 2023);

– ISPRA core sample database deeper than 30 meters (acquired in compliance with Law 464/84) (ISPRA 2023);
– core samples collected in the SITAR database (SSABAP-Rm 2023);
– personal database of geologist Carlo Rosa.

5. Case study of the section between Vatican hill and the Colosseum

The main case study conducted for this article concerns Rome between piazza Venezia and San Giovanni in Laterano and involves the use of the SITAR platform. The study focuses on calculating archaeological potential by examining geological and urban surfaces. The key elements of the study include: 1) geological surface: the 'Modified Geological Surface' represented in blue; 2) urban surface: the current urban surface represented in red. The methodology involved several steps, integrating geological and archaeological data to evaluate potential archaeological layers in the specified area:

– data collection: geological core samples and archaeological excavation data were collected throughout the city. These were analyzed by the geologist and mapped in QGIS, documenting the altitude above sea level of the geological surface below the archaeological layers;
– surface reconstruction: two fundamental DEM surfaces were defined: 1) upper surface: the current urban surface from the CTR Lazio 2002; 2) lower surface: the reconstructed geological surface modified by both natural and anthropogenic activities over time (search radius 500 m).

Once the two surfaces were obtained, the result was validated by performing hundreds of sections across the territory of Rome directly in the QGIS environment. The sections were sampled using the 'Profile tool' plugin. The results allowed for corrections and indicated significant differences between the geological and urban surfaces (Fig. 5). There is the possibility of increasing the detail of this section through more in-depth archival study, filling the gap between the two surfaces with archaeological structures or natural surfaces (Fig. 5b). Various modifications to the geological surface were identified, including fills and anthropogenic erosions. The impact of urban development on archaeological layers was assessed, with significant fill layers identified in some areas. Thanks to a multidisciplinary collaboration between archaeologists and geologists within the SITAR group, the enrichment and characterization of the section were achieved, demonstrating elements of great interest. As illustrated in the image (Fig. 6), the section between Vatican hill (*ad Saxia*) and piazza Venezia is meticulously explained in the legend. The evolution of the surfaces is reconstructed by intersecting all available data. Using the same methodologies, we can potentially outline the main archaeological deposits and major anthropogenic erosions throughout the Municipality of Rome, covering over 1200 km².

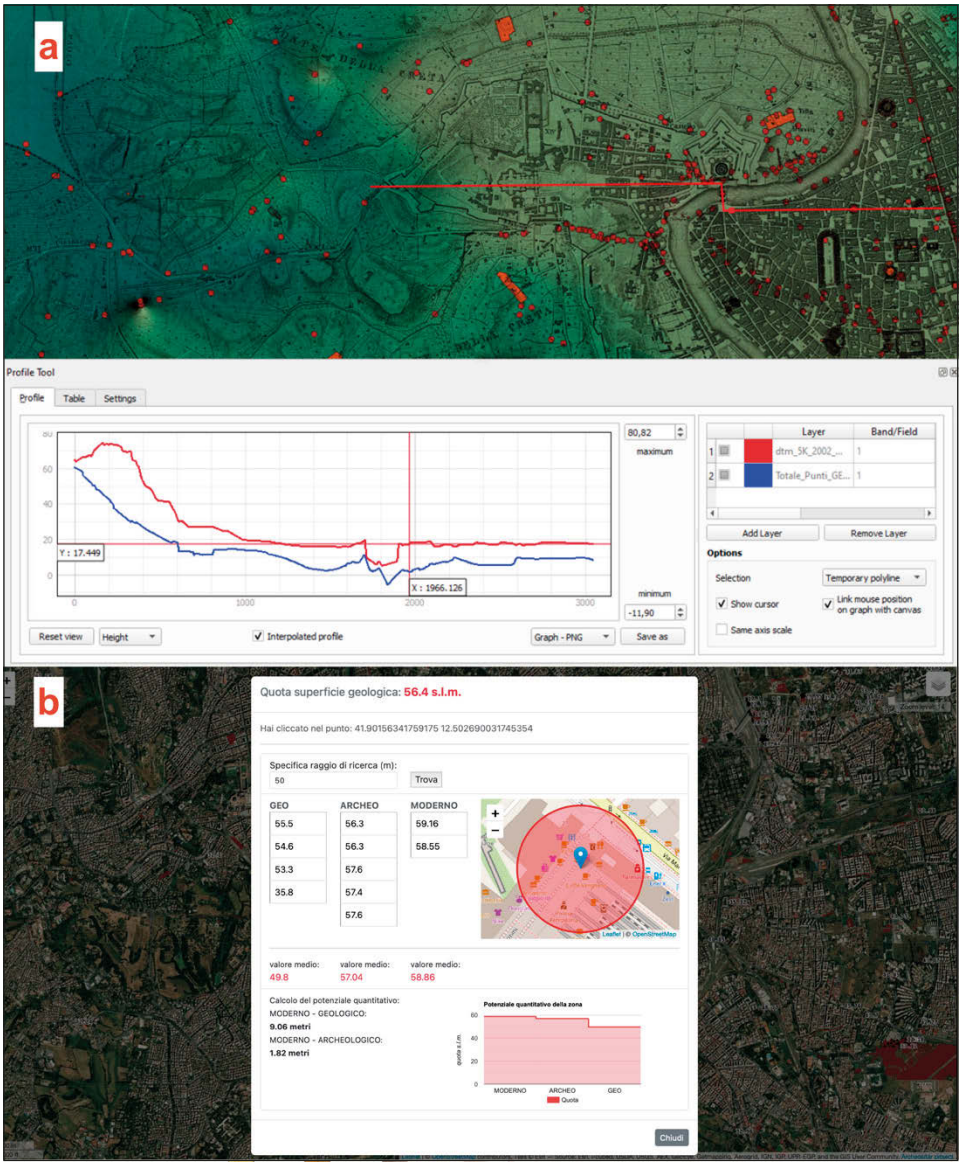

Fig. 5 – a) Current surface (red) and geological surface (blue). The section crosses St. Peter's Basilica, then piazza Pia, crosses the Tiber at Ponte Elio, and ends at via del Corso (*Via Lata*); b) the SITAR prototype of the webGIS tool for sampling quantitative archaeological potential in Rome. The tool averages the elevations within a search radius around the clicked point; in this case, the click was made at Termini (map and section processing by Paolo Rosati, webGIS application by Ascanio D'Andrea).

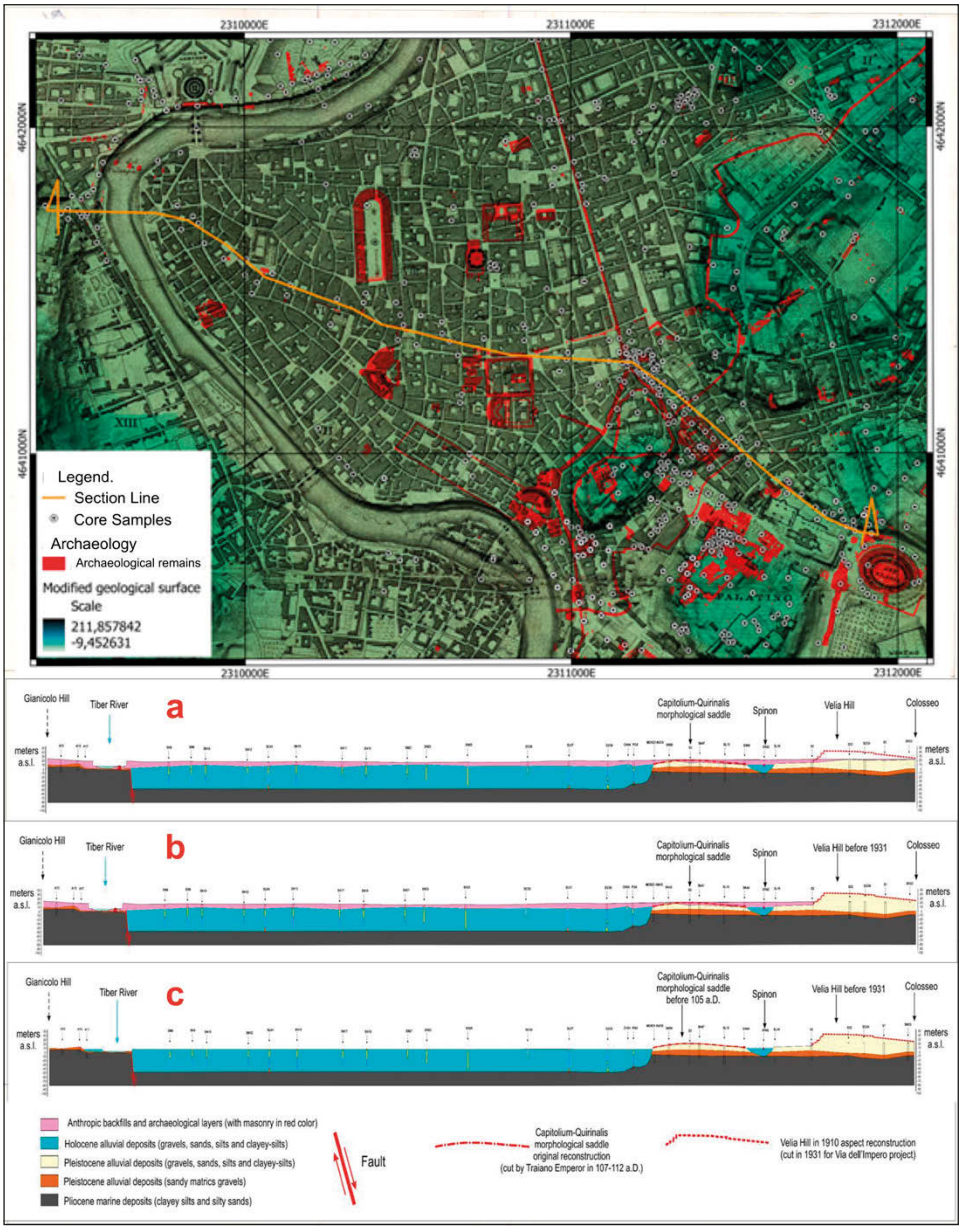

Fig. 6 – From Vatican hill to the Colosseum, an archeo-geological section from (a) today, (b) in the 1920s, and (c) before 10 AD (map processing by Paolo Rosati, sections by Carlo Rosa).

6. Conclusions

As we have seen, two centuries have passed since Brocchi's geological and antiquarian analysis, whose *Carta fisica del suolo di Roma* was intuitively used by archaeologists as a foundation to narrate the origins of the city Roma *ab Urbe condita*. These reconstructions have been enriched by the results of stratigraphic excavations and further epigraphic and historical evidence, providing an increasingly detailed picture of the territory. In SITAR, the original path traced by Brocchi is aimed at creating a reconstructive DEM of the Modified Geologically Surface, deducing a solid geo-archaeological compendium.

In line with SITAR's policy of knowledge democracy, the cartography will be published on the portal, and the DEMs will be accessible to everyone thanks to the ease of use offered by webGIS (Fig. 5b). Users, by clicking on any point in the city, will be able to obtain precise and detailed data as if they were conducting a specific coring. Among the data made available will be:

– the current altitude above sea level (modern);
– the summit elevation of the archaeological deposit;
– the average thickness of the archaeological deposit (if remains or previous excavations are present nearby);
– the average elevation of the geological layer.

By combining this new tool in development with what is already present on the platform, SSABAP aims to create an open and accessible device for everyone (public, academia, technical users). These openly shared data will

Fig. 7 – (Left) Detail of the *Carta fisica del suolo di Roma* drawn by Brocchi in 1820 and (right) the 'Modified Geological Surface' with the main water stagnation basins highlighted graphical processing by Paolo Rosati on SITAR data.

be made available to provide cutting-edge service, continuously updated, and we hope will generate new knowledge for a better future for the city.

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ABSTRACT

The institutional goal of studying and mapping archaeological potential in SITAR in recent years has been to create an efficient tool to support urban planning and cultural heritage management: The Archaeological Potential Map of Rome. The Soprintendenza of Rome plays a key role in this effort, being responsible for the safeguarding and promotion of the city's archaeological heritage. By developing a robust model of archaeological potential, the Soprintendenza can better anticipate and mitigate the impact of construction and development projects on archaeological sites. This proactive approach ensures that significant archaeological resources are identified and preserved before they are damaged or destroyed. The tool will facilitate informed decision-making in urban planning, helping to balance the needs of modern development with the preservation of historical sites. Moreover, it will support the regulatory framework that mandates archaeological assessments in high-potential areas, rationalisation of administrative processes and improving compliance with heritage protection regulations. Overall, the creation of an efficient archaeological potential model by the Soprintendenza of Rome underlines the commitment to preserving the city's cultural heritage while accommodating its continuous urban evolution.