

The Map of Altinum, Ancestor of Venice

Andrea Ninfo,* Alessandro Fontana, Paolo Mozzi, Francesco Ferrarese

The urban structure of Altinum [Fig. 1B and fig. S2 (1)], an important Roman harbor on the inner margin of the Lagoon of Venice [fig. S2 (2)], has until now been largely unknown. This city, Roman Municipium since the first century before the common era (B.C.E.), plays an important role in the early history of Venice because its inhabitants colonized the northern lagoon islands when fleeing from Barbarians [fifth to seventh century C.E. (3–5)]. We used visible and near-infrared (NIR) aerial photographs [Fig. 1A and fig. S1 (1)] and a digital elevation model (DEM) to reconstruct the urban topography and paleoenvironmental setting of Altinum.

The reuse of stones and bricks of the abandoned buildings for the construction of Venetian palaces and churches led to the dismantling of Altinum (3). The ruins of the city were partially drowned in the lagoon by relative sea-level rise (5). After 20th-century land reclamation, archaeological excavations were performed outside the city walls, centered on segments of the Roman roads (Via Annia and Augusta) and on the Roman and Iron Age necropolis and sanctuaries (2). With a size comparable to Pompeii, Altinum is the only large Roman city in Northern Italy and one of the few in Europe that has not been buried by medieval and modern cities. This setting allows spatial investigation through remote sensing.

Our images were taken at the end of July 2007, during severe drought, which caused water stress of the maize and soy crops in the area (fig. S3). The NIR radiation, which is highly sensitive to vegetation health, highlights the archaeological features. The lighter crop marks (Fig. 1A) show the subsurface presence of stones, bricks, or compacted soil; the dark ones correspond to depressed features like pits, spoliation hollows, canals, and paleo-channels filled with silty-clay sediments.

The images reveal ancient urban fabric and waterways (Fig. 1B), the city walls and gates, the street network, dwellings with their internal divisions, and monumental buildings (e.g., theater, odeon, amphitheater, forum with emporia, and basilica). The monumental buildings can be attributed to the period of maximum urban expansion [first century B.C.E. to first century C.E. (2)].

The city was surrounded by a complex network of rivers and canals (fig. S2); a large canal crossed the urban center, which connected it to the lagoon. The DEM shows that the city was on top of a 2- to 3-m-high rise. Considering the position of the coastline in Roman times (6, 7), the lagoon probably extended to the foot of the mound. Altinum was partially surrounded by water as described by the geographer Strabo in the first century B.C.E.

Our results indicate the existence of a complex urban structure with varied and outstanding architecture that was adapted to the peculiarity of the lagoon environment. These data show that Romans successfully exploited the amphibious environment several centuries before the city of Venice started to emerge on the archipelago in the middle of the lagoon (4).

References and Notes

1. Materials and methods are available as supporting material on Science Online.
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Supporting Online Material

www.sciencemag.org/cgi/content/full/325/5940/577/DC1
Materials and Methods

Figs. S1 to S3

References

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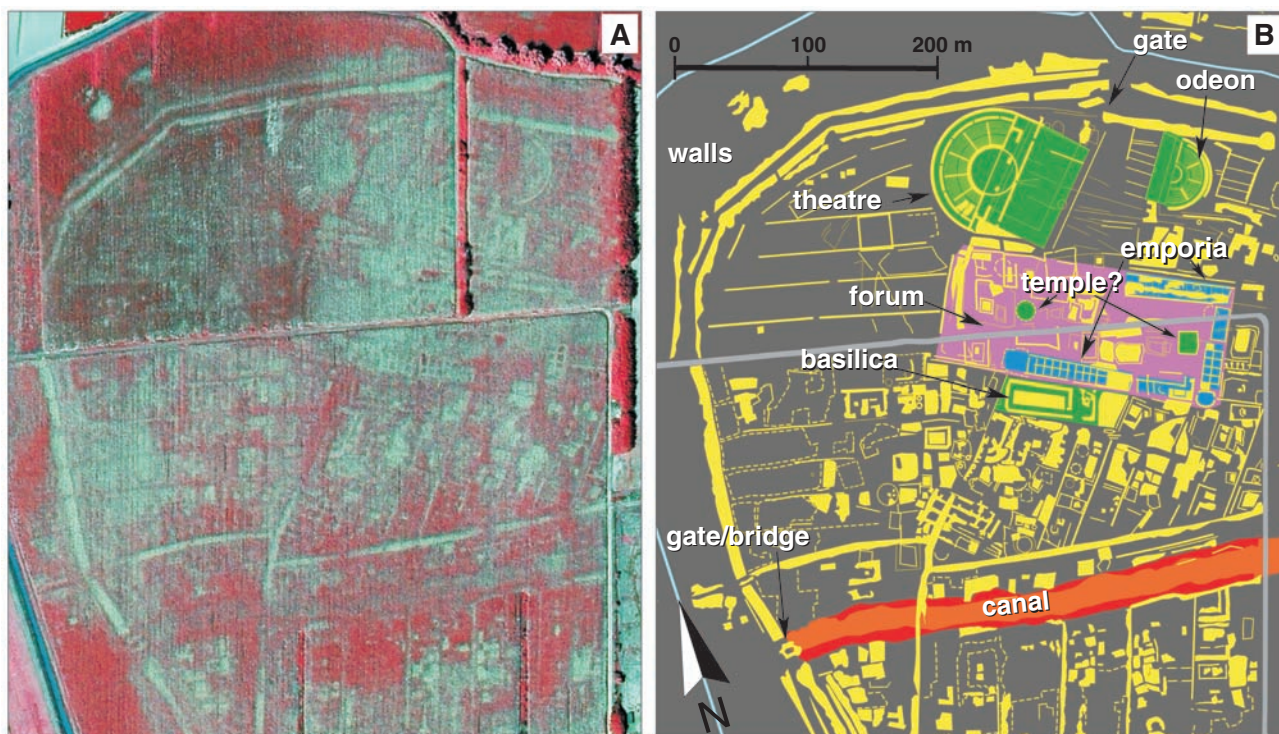


Fig. 1. (A) Digitally enhanced false-color composite image (NIR, red and green spectral bands) of the center of the Roman city (Realvista 2007, Telespazio S.p.A., Rome, Italy), with maize and soy crop marks. (B) Interpretation of (A).



Supporting Online Material for

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Supporting Online Materials (SOM)

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Materials and methods

Data processing

The images (bands: 0.38-0.60, 0.48-0.68, 0.58-0.72, 0.68-1.0 μm ; pixel size 0.5 m) were acquired on 31/07/2007. Stretch, directional filter and vegetation index (e.g. NDVI and Vegetation Suppression) were applied in the image processing (fig. S1). The DEM is interpolated from the elevation points, with centimetric resolution, of the Veneto Region topographic maps, scale 1:5000 (fig. S2). Historical maps (Austrian Kriegskarte, 1798-1805, scale 1:28,000; time series of the Italian Military Geographic Institute topographic maps, scale 1:25,000, since 1903) have been georeferenced and interpreted in order to understand the evolution of modern field patterns and hydrography. This allows for the recognition of the features connected to 20th century land reclamation, which have been excluded from the reconstruction of the Roman landscape.

Climatic setting

Average July rainfall between 1961-1991 at Roncade meteorological station, 10 km north of Altinum, is 70 mm (data source: Environmental Protection Agency of Veneto – ARPAV). July 2007 was very dry, with only 28 mm concentrated in the first part of the month (fig. S3). The lack of precipitation after 11/07/2007, associated with maximum air temperatures, led to zero leaf wetness for some days. This drought represented a stress factor for the maize and soy crops in the study area, mitigated only by the 2 mm of rainfall on 30/07/2007, the day before image acquisition.

Supporting figures



Fig. S1 Digitally enhanced false-color composite image (near IR, Red, Green) of the area of Altinum (Realvista 2007, Telespazio SpA); the top of the image is North oriented.

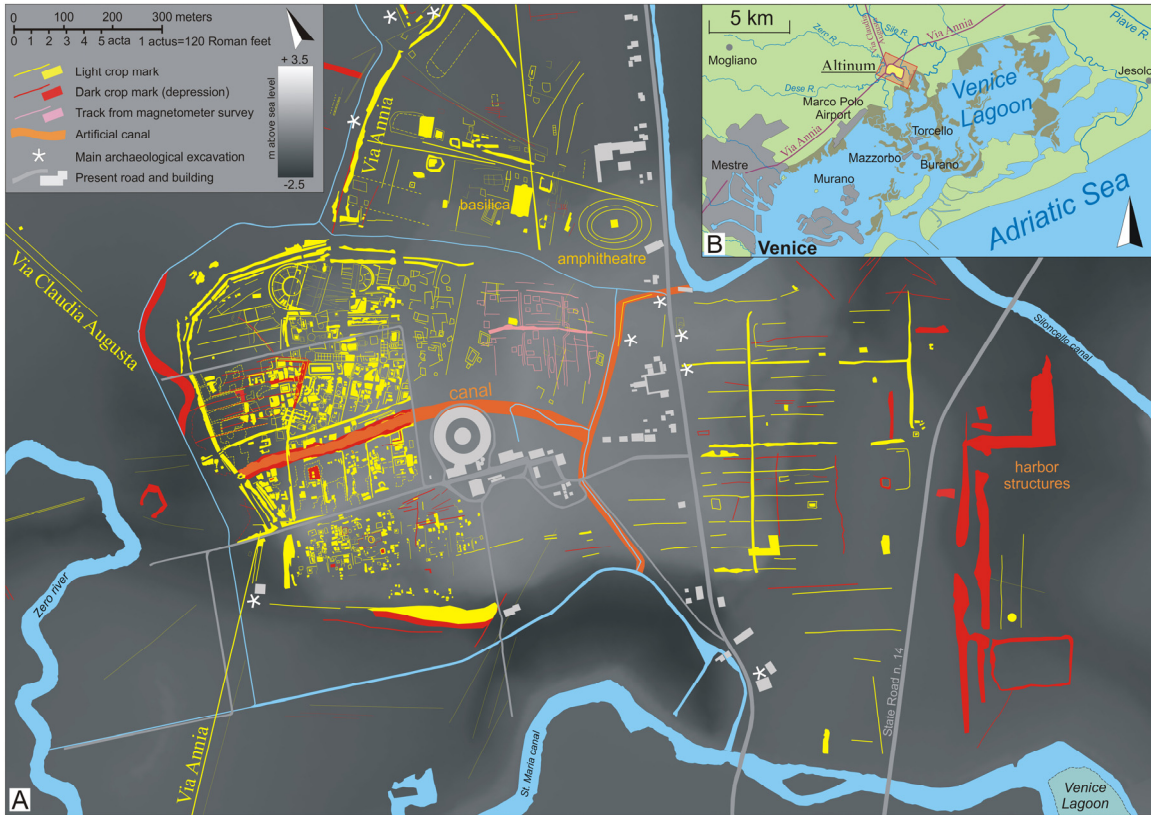


Fig. S2 (A) Map of the whole Roman city of Altinum draped on the DEM; tracks from magnetometer survey are interpreted from (S1); main archaeological excavations (S2, S3, S4, S5, S6, S7). (B) Geographic setting; grey: urban areas; brown: salt marshes; green: alluvial plain and coastal areas.

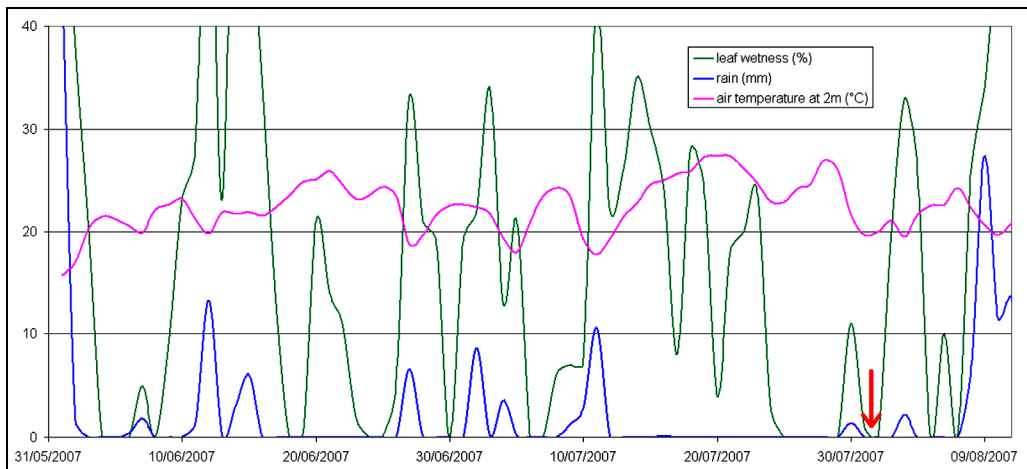


Fig. S3 Rain, air temperature and leaf wetness at Roncade meteorological station during the two months that preceded image acquisition (31/07/2007, indicated by the red arrow) (Data source: Environmental Protection Agency of Veneto – ARPAV).

Supporting references

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