Modeling Domestic Architecture at Late Minoan IIIC Vronda, Kavousi, Crete

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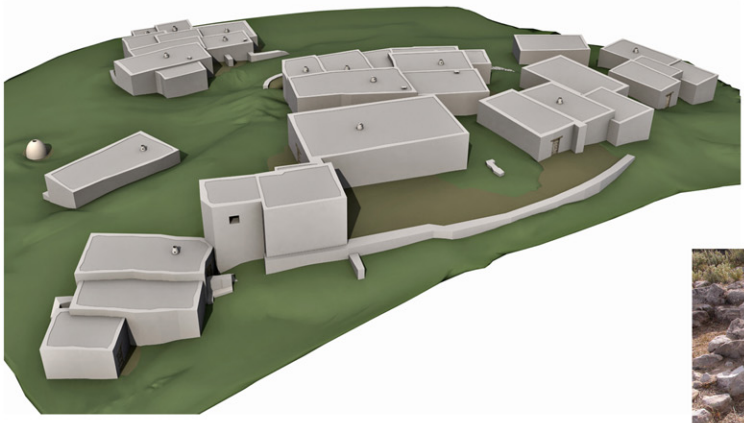
Photograph of the Vronda settlement from the southeast (2003).

Excavations at the archaeological site of Kavousi Vronda in eastern Crete brought to light a small rural settlement dating to the LM IIIC period (12th–early 11th centuries B.C.). The site was first explored very briefly by Harriet Boyd Hawes in 1900, while more extensive excavations were conducted by the Kavousi Project (1983-1984, 1987-1990, 1992) under the direction of Geraldine C. Gesell, Leslie P. Day and William D. E. Coulson. These investigations have shown that by the time of abandonment the settlement consisted of 15–20 houses, a large building with storerooms that may have been the ruler's dwelling, a communal temple or shrine of the 'goddess with upraised arms,' and a kiln. While abandonment and postabandonment processes have resulted in much disturbance, Vronda has provided a wealth of data for understanding LM IIIC domestic architecture, household activities, religion and society at the end of the Bronze Age.

This poster presents a digital reconstruction of the Vronda settlement based upon the 'analog' data recorded at the time of excavation, discusses the process of creation and examines the potential contributions of such models for understanding the built environment and vernacular architecture of ancient Crete.



Rough 3D rendering of the Vronda model from the southeast. For the purposes of research, achieving a completely 'realistic' appearance is not always necessary. In many ways, the simplified and more abstract rendering communicates as much (or more) information to specialists than a photorealistic depiction.

Room I3 from the west: actual state of preservation in 2007 (above) and virtual reconstruction (below; screenshot from 360° Quicktime VR). The juxtaposition of the two images highlights the important distinction between archaeological data and interpretation, and between 'reality' and 'realism.' The virtual room can be populated with artifacts and features in the locations where their real-life counterparts were actually found. The storage jar (pithos) represented here was smashed on the floor of Room I3, but has never been restored except on paper – and now in a 3D computer model. The result is a virtual composite of stratigraphic, ceramic, and spatial data in a single image.

Final composite rendering of Building I from the north. Screenshot from a video fly-through of the model (YouTube - search 'Vronda'). Photorealistic renderings such as the one illustrated above are more dramatic and 'life-like,' and are especially useful for pedagogical purposes and public consumption.

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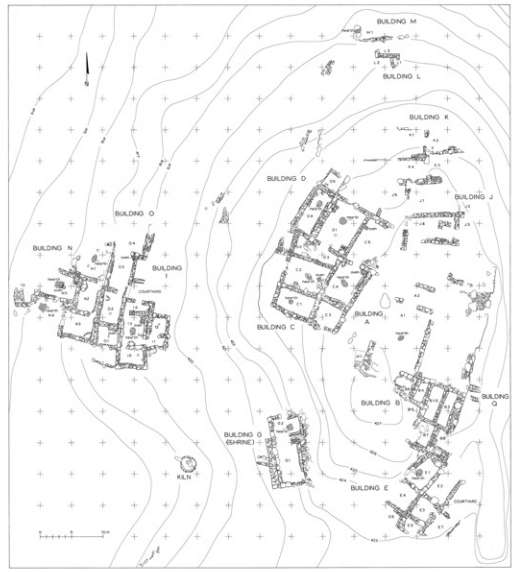
Project Goals

The primary goal of the modeling project is to promote a visual understanding of the Vronda settlement according to the interpretations of the archaeological data by members of the Kavousi excavation team. For our study of the Vronda architecture, we are especially interested in

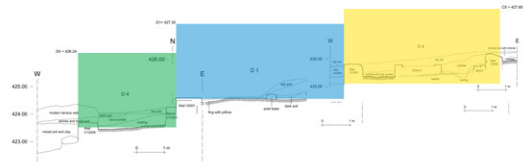
- creating a versatile 3D model that complements photographs, traditional two-dimensional plans, sections and elevations
- discovering effective and innovative ways of presenting our analysis of architectural morphology (mass, height, form, scale, sequence of construction) of individual buildings and complexes
- exploring spatial relationships within the settlement, paths of access and communication, communal spaces between buildings, hierarchy and function



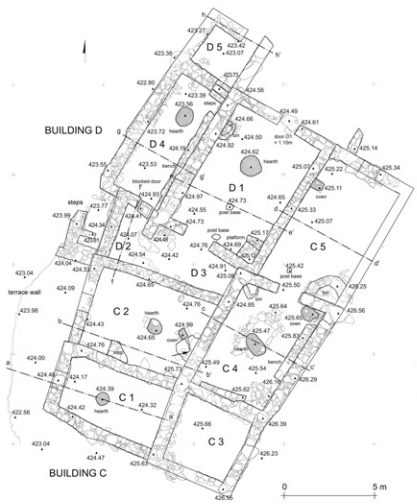
Vronda: Plan of the LM IIIC settlement. Later remains, in particular Geometric cist graves that reused parts of the abandoned and partially collapsed LM IIIC buildings, are not indicated.

Process

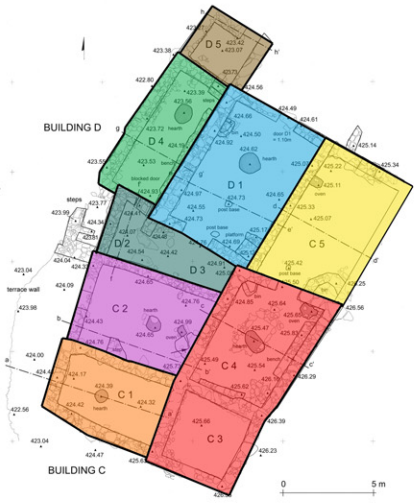
The creation of a high quality 3D model requires close collaboration between the archaeologist and the architect/computer graphics specialist. The accuracy and usefulness of any reconstruction will depend upon the degree of preservation of the material, the accuracy of the recorded data, and the quality of the archaeological research combined with access to appropriate technology and skills. Our process involves several stages of data input, preliminary modeling, feedback, compromises and 'interpretive leaps' to compensate for incompletely preserved remains, and revision.



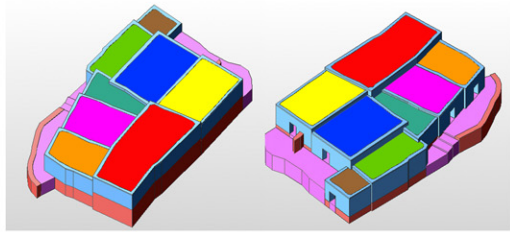
Architectural section through Rooms C5, D1, and D4 indicating conjectural wall/roof heights to be used in the model.



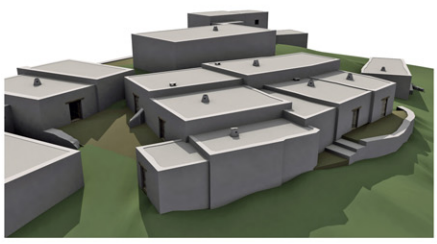
Building CD: State plan with preserved and restored wall thicknesses, doors and other features clearly indicated. By the time of its abandonment, Building CD may have comprised as many as 5 different households, and the plan reflects several clearly defined architectural phases.



Color-coded plan illustrating likely sequence of construction and proposed architectural massing units (rooms that will share the same roofline in the model).



Preliminary massing model of the Building CD complex created in AutoCAD. Exported as a DWF file, this model can be easily reviewed for accuracy and rotated to view the reconstruction from different perspectives.

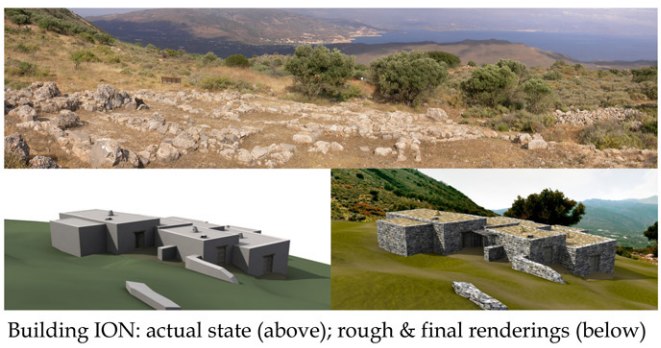


The AutoCAD model of each building complex is then imported into AutoDesk 3ds Max, where it is added to a previously created topographic model of the site. (Since we did not have access to high-resolution survey data, we used a digitized version of the site map (1 m contours) created using traditional [i.e., non-electronic] survey techniques prior to excavation in the 1980s.). At this stage, features such as chimneys and doors are added. A **rough 3D rendering**, without additional texturing for walls or roofs, is produced to show the building in relationship to the topography and other structures.

For a **final composite rendering**, textures (images of stones, clay, etc.) are 'mapped' onto walls, roofs and other features. 2D panoramic photos taken from the summit of the hill are also mapped onto a cylinder surrounding the model to provide a photorealistic representation of the background landscape from any camera angle. (At a later stage, still-shots of the model can be merged with photographs of the actual landscape in the foreground.). A spotlight was created in 3ds Max to act as a virtual sun casting shadows corresponding to the time of day in the 2D photograph, while an advanced lighting plug-in was used to replicate the environmental global illumination. In this way the background was 'camera matched' to the computer generated renders.

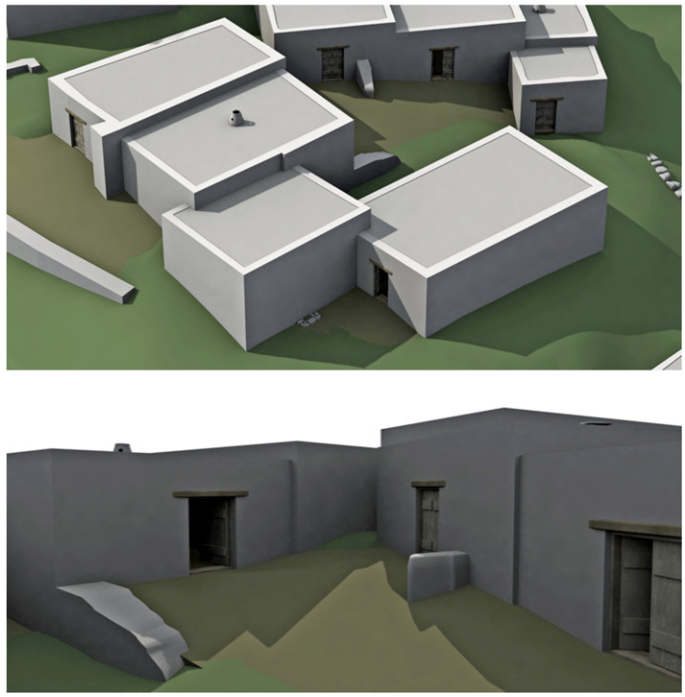
'Interpretive Leaps'

One of the major challenges faced by archaeologists, especially those who excavate prehistoric and non-monumental remains, is how to reconstruct the 'missing' elements. In order to complete our 3D model, certain 'interpretive leaps' were necessary. Since none of the buildings at Vronda were preserved anywhere near full height, and most organic materials used in construction had decayed long ago, we made decisions for the reconstruction based upon 1) the excavated remains, 2) comparisons with other Minoan sites, and 3) the vernacular building traditions of eastern Crete, especially structures from nearby villages, hamlets, and fieldhouses in the Kavousi region (above). In addition to the use of locally available resources, these 'modern' buildings often share striking similarities to the Late Bronze/Early Iron Age structures excavated by the Kavousi Project (e.g., agglomerative sequence of construction following natural topographic contours, walls founded directly on bedrock, stone masonry techniques, flat clay roofs, accumulation of thick deposits of roofing clay on the floor during abandonment and collapse) and provide important analogies for our study of ancient domestic architecture and our understanding of site formation processes. Since the apparent realism of 3D architectural renderings can sometimes make it difficult for viewers to determine which elements are based on 'real' archaeological data and which are 'interpretive leaps' made during the modeling process, great care should be taken to distinguish between the original evidence and the inferences used in the virtual reconstruction.



Building ION: actual state (above); rough & final renderings (below)

'Using Vision to Think'



Specialists in information science have emphasized that effective visualization promotes understanding on many different levels, including the cognition of large amounts of data, the perception of unanticipated properties, the recognition of problems in data quality, the clarification of relationships of both large- and small-scale features, and the formulation of new hypotheses. The virtual reconstruction of Vronda has already offered us many fresh perspectives on the built environment of the community, especially concerning the relationships between building complexes. For example, the model allows us to visualize more clearly a shared courtyard between Buildings CD and JK (above), accessible from the northwest (between Rooms D5 and K1) and through a narrow 'alley' at the southeast (between Rooms C5 and J4). While Buildings CD and JK have been analyzed and discussed separately in the Kavousi publications, the model now prompts us to consider the activities and social interaction that may have taken place in this semi-enclosed space and whether parts of the two complexes formed a type of 'courtyard group.'

As our work progresses, we intend to use the 3D model in conjunction with other software applications to address a variety of research questions concerning ancient architecture, such as the amount of material used in construction, the relationship of architectural form to environmental conditions, and the heating, lighting and ventilation of interior spaces based upon different reconstructions of hearths, ovens, doors, windows and chimneys.

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